Cat.No. Z207-E1-01

ZFV Series

# Smart Sensors

## with Ultra-High-Speed CCD Cameras

# USER'S MANUAL

OMRON

| | |
|---|---|
| INTRODUCTION | APPLICATION CONSIDERATIONS (Please read first) |
| SECTION 1 | FEATURES |
| SECTION 2 | INSTALLATION & CONNECTION |
| SECTION 3 | SETUP |
| SECTION 4 | APPENDIX |




# User's Manual

Smart Sensors
with Ultra-high-speed CCD Camera
ZFV Series

## READ AND UNDERSTAND THIS DOCUMENT

Please read and understand this document before using the products. Please consult your OMRON representative if you have any questions or comments.

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The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this document.
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## PERFORMANCE DATA

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## CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased products.

## DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

## ERRORS AND OMISSIONS

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# Precautions for Safe Use

Please observe the following precautions for safe use of the products.

**(1) Installation Environment**

- Do not use the product in environments where it can be exposed to inflammable/ explosive gas.
- Install the Amplifier Unit in such a way that the ventilation holes are not blocked.
- To secure the safety of operation and maintenance, do not install the product close to high-voltage devices and power devices.
- During installation, make sure that screws are tightened firmly.

**(2) Power Supply and Wiring**

- The supply voltage must be within the rated range (DC24V±10%).
- Reverse connection of the power supply is not allowed.
- Open-collector outputs should not be short-circuited.
- Use the power supply within the rated load.
- High-voltage lines and power lines must be wired separately from this product. Wiring them together or placing them in the same duct may cause induction, resulting in malfunction or damage.

**(3) Others**

- During installation, make sure that screws are tightened firmly.
- Do not attempt to dismantle, repair, or modify the product.
- Dispose of this product as industrial waste.
- Should you notice any abnormalities, immediately stop use, turn OFF the power supply, and contact your OMRON representative.

# Precautions for Correct Use

Please observe the following precautions to prevent failure to operate, malfunctions, or undesirable effects on product performance.

**(1) Installation Site**

Do not install the product in locations subjected to the following conditions:

- Ambient temperature outside the rating
- Rapid temperature fluctuations (causing condensation)
- Relative humidity outside the range of 35 to 85%
- Presence of corrosive or flammable gases
- Presence of dust, salt, or iron particles
- Direct vibration or shock
- Reflection of intense light (such as other laser beams or electric arc-welding machines)
- Direct sunlight or near heaters
- Water, oil, or chemical fumes or spray
- Strong magnetic or electric field

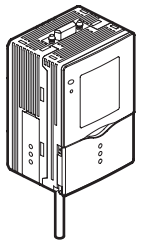
**(2) Power Supply and Wiring**

- When using a commercially available switching regulator, make sure that the FG terminal is grounded.
- If surge currents are present in the power lines, connect surge absorbers that suit the operating environment.
- Before turning ON the power after the product is connected, make sure that the power supply voltage is correct, there are no incorrect connections (e.g. load short-circuit) and the load current is appropriate. Incorrect wiring may result in breakdown of the product.
- Before connecting/disconnecting the Sensor Head, make sure that the Smart Sensor is turned OFF. The Smart Sensor may break down if the Sensor Head is connected or disconnected while the power is ON.
- Use only combinations of Sensor Heads and Sensor Controllers specified in this manual.
- Do not turn the power OFF in the following instances
  -Immediately after the MENU mode or ADJ mode is switched to the RUN mode
  -During startup in the RUN mode
  -Wait for the ENABLE signal to turn ON before turning the power OFF as the bank data may be initialized.

**(3) Orientation when Installing the Amplifier Unit**

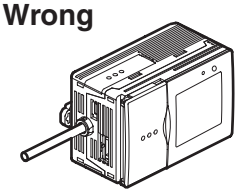
To improve heat radiation, install the Amplifier Unit only in the orientation shown below.

**Right**

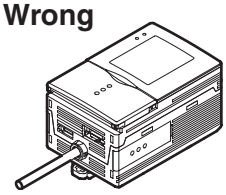


Do not install the Amplifier Unit in the following orientations.

**Wrong**



**Wrong**



**(4) Maintenance and Inspection**

- Do not use thinner, benzene, acetone or kerosene to clean the Sensor Head and Amplifier Unit.
- If large dust particles adhere to the front Panel of the Sensor Head, use a blower brush (used to clean camera lenses) to blow them off. Do not blow the dust particles with your mouth.
- To remove smaller dust particles, wipe gently with a soft cloth. Do not use excessive force to wipe off dust particles. Scratches on the front Panel may cause errors.

**(5) Optical Axis and Detection Range**

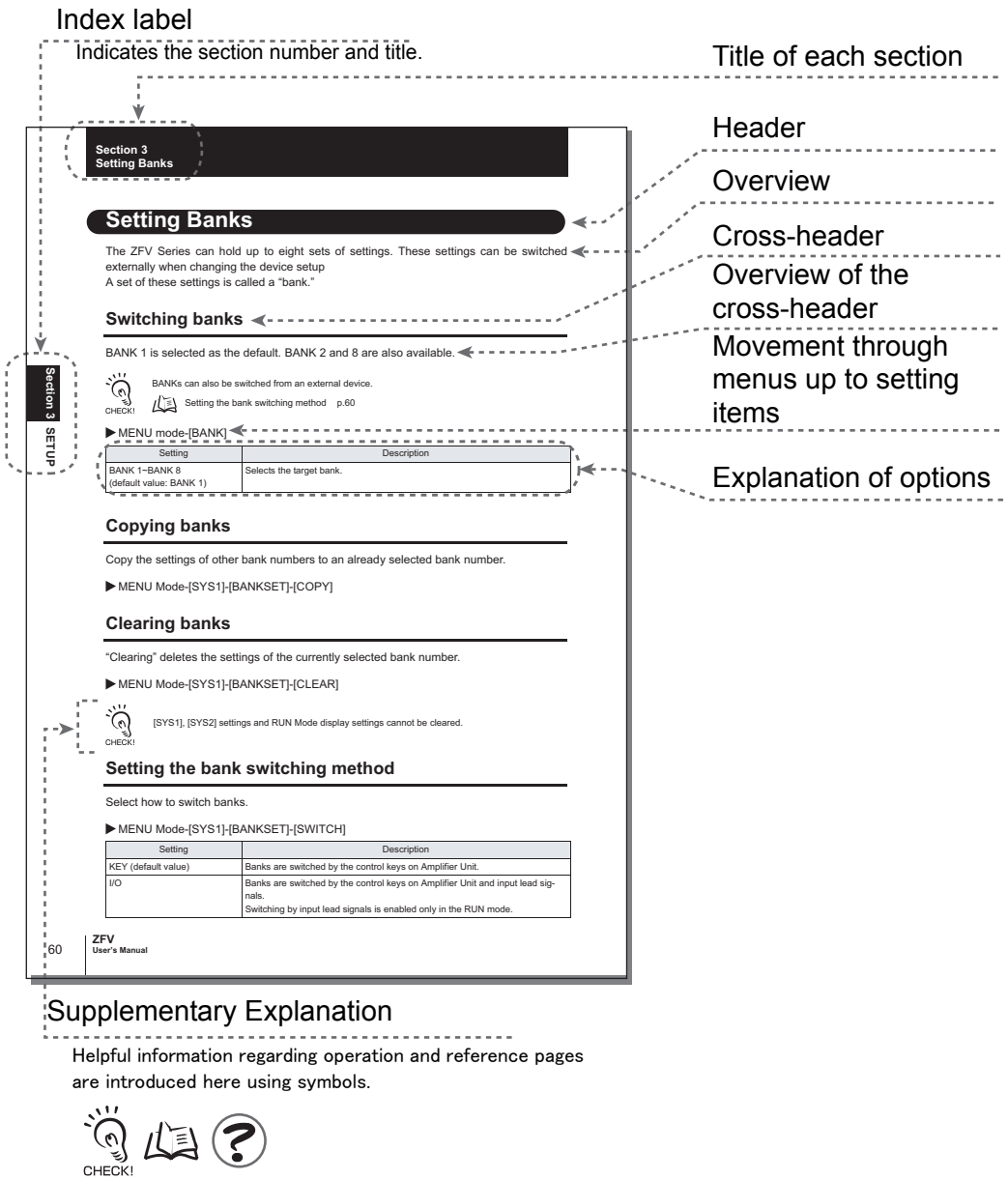
The center of the guide light and detection range are for reference only.
The center of the optical axis sometimes differs according to each Sensor Head. During installation, be sure to check the center of the image and the detection range on the LCD monitor of the Amplifier Unit.

**(6) Ventilation Film**

- Do not peel off or probe the ventilation film with a sharp-pointed object. If you so, the specifications of the protective structure may no longer be satisfied.
- Do not block the ventilation film. Doing so might cause the front panel to be condensed.

# Editor's Note

## Page Format


Index label
Indicates the section number and title.
Title of each section
Header
Overview
Cross-header
Overview of the cross-header
Movement through menus up to setting items
Explanation of options
Section 3
Setting Banks
Setting Banks
The ZFV Series can hold up to eight sets of settings. These settings can be switched externally when changing the device setup
A set of these settings is called a "bank."
Switching banks
BANK 1 is selected as the default. BANK 2 and 8 are also available.
BANKs can also be switched from an external device.
CHECK!
Setting the bank switching method p.60
Section 3 SETUP
▶MENU mode-[BANK]
Setting
Description
BANK 1–BANK 8 (default value: BANK 1)
Selects the target bank.
Copying banks
Copy the settings of other bank numbers to an already selected bank number.
▶MENU Mode-[SYS1]-[BANKSET]-[COPY]
Clearing banks
"Clearing" deletes the settings of the currently selected bank number.
▶MENU Mode-[SYS1]-[BANKSET]-[CLEAR]
CHECK!
[SYS1], [SYS2] settings and RUN Mode display settings cannot be cleared.
Setting the bank switching method
Select how to switch banks.
▶MENU Mode-[SYS1]-[BANKSET]-[SWITCH]
Setting
Description
KEY (default value)
Banks are switched by the control keys on Amplifier Unit.
I/O
Banks are switched by the control keys on Amplifier Unit and input lead signals.
Switching by input lead signals is enabled only in the RUN mode.
60
ZFV
User's Manual
Supplementary Explanation
Helpful information regarding operation and reference pages are introduced here using symbols.
CHECK!

*This page has been made purely for explanatory purposes and does not exist.

## ■ Meaning of Symbols

Menu items that are displayed on the Amplifier Unit's LCD screen are indicated enclosed by brackets [ ].

## ■ Visual Aids

Indicates points that are important to ensure full product performance, such as operational precautions and application procedures.

Indicates pages where related information can be found.

Indicates information helpful in operation.

EXP MENU Indicates functions that can be set only when the setup menu has been switched to EXP menu.

# CONTENTS

Precautions for Safe Use 4
Precautions for Correct Use 5
Editor's Note 7
Page Format 7
CONTENTS 9

SECTION 1 FEATURES 13

ZFV Smart sensor Features 14
Basic Configuration 16
Part Names and Functions 18

SECTION 2 INSTALLATION & CONNECTION 21

About Installation and Connection 22
Amplifier Unit 23
Attaching the ferrite core 23
Installing the Amplifier Unit 23
Gang mounting 27
About the I/O cable 31
Timing charts 34
Sensor Head 37
Attaching the ferrite core 37
Installing the mounting fixture 37
Installing the Sensor Head 38
Connecting the Sensor Head 40

SECTION 3 SETUP 41

Setting Flow 42
About Setup 44
Basic Knowledge for Operation 44
List of Setting Items in MENU mode 46
Executing Teaching 48
Teaching Flow 48
Types of Teaching 49
Adjusting Threshold Values 53
Performing Measurement 57
Setting Banks 58
Switching banks 58
Copying banks 58
Clearing banks 58
Setting the bank switching method 58
Setting the System Environment 59
Adjusting the measurement speed 59
Selecting the measurement timing 59
Selecting the teaching mode from an external device 59
Setting/canceling the “Eco” mode 60
Initializing setup data 60
Checking the version 60
Changing the Input/output Conditions 61
Selecting the ON conditions 61
One-shot output 61
Setting the ON delay time 62
Setting the OFF delay time 63
Settings during application extended connection 63
Specifying the Amplifier Unit to input the trigger 64
Setting the presence of Sensor Head 64
Setting output content 64

Customizing Measurement conditions 65
Common items 65
PATTERN/SEARCH, MATCH 66
BRIGHT 67
AREA 68
WIDTH 69
POSITION 70
COUNT 71
CHARA/CHARA 1, CHARA 2 72

SECTION 4 APPENDIX 77

Troubleshooting 78
Error Messages and Remedies 79
Q&A 80
Run Mode Display Item List 81
Specifications and External Dimensions 83
Sensor Head 83
Amplifier Unit 85
Panel Mount Adapters 87
Control Link Unit 88
INDEX 89
Revision History 92

MEMO

# Section 1
# FEATURES


ZFV Smart sensor Features 14

Basic Configuration 16

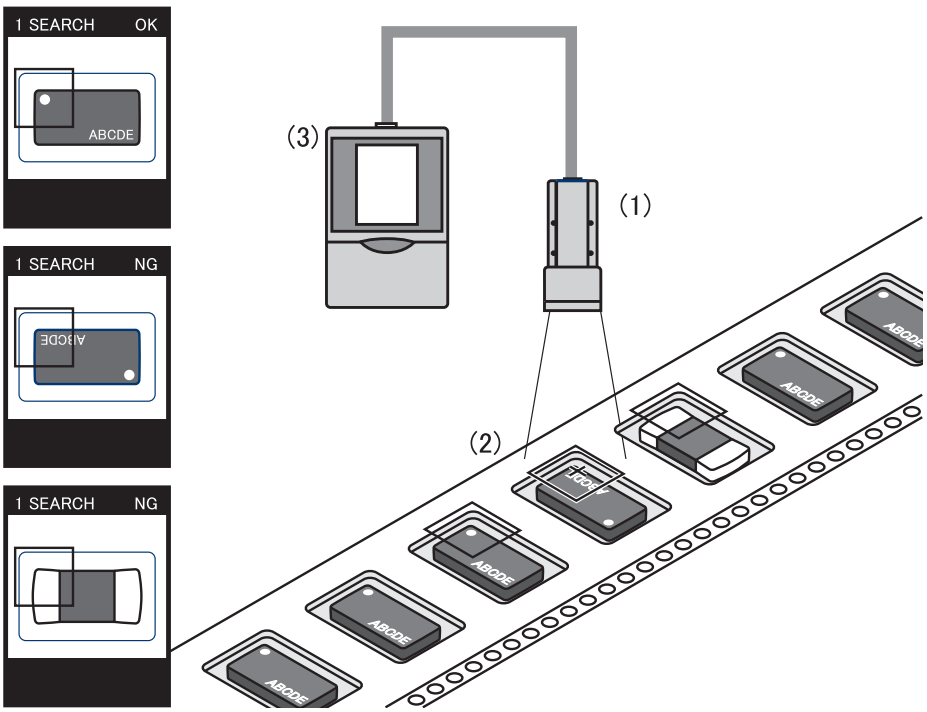
Part Names and Functions 18

# ZFV Smart sensor Features



The ZFV sensor senses objects by its “surface.” How objects are being sensed can be easily set while verifying on the LCD monitor.
The ZFV also incorporates a 250,000-pixel CCD equivalent to that of a Conventional machine vision sensor. This allows presence detection and recognition of different objects, which have up till now been performed visually, to be executed fast and accurately.

■ Recognition of top/rear side and orientation of electronic components




**(1) Compact Sensor Head**
The LED light emitting section and lens are built into the compact Sensor Head. The Sensor Head takes up little installation space.

**(2) Easy Installation and Adjustment**
The range that can be sensed by Sensor Head can be confirmed by the guide light. So, the Sensor Head can be installed by viewing the position of the guide light and its focus.

### (3) Business Card-size Amplifier Unit

- The Amplifier Unit is designed to be compact so that it can be installed at a wide range of sites.

Specifications and External Dimensions p.83

- Outstanding operate ease has been achieved by a 1.8″color LCD motor, an industry-first icon-based menu, and simple key layout.

Basic Knowledge for Operation p.44

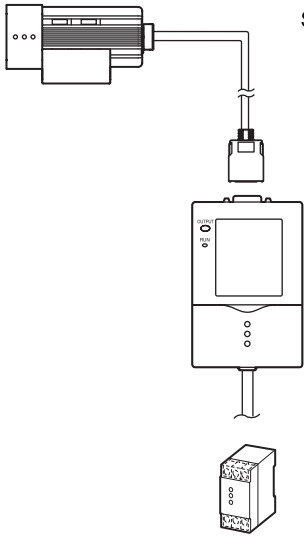
- The ZFV incorporates an extensive range of measurement items which means that numerous applications are supported.

Types of Teaching p.49

# Basic Configuration



The figure below shows the Basic Configuration of the ZFV Series.



Sensor Head

Detects workpieces as images.
- Narrow view type ZFV-SR10
- Wide view type ZFV-SR50

Amplifier Unit

Used for confirming images and menus, performing measurement processing, and outputting the result of processing.
- Single-function type ZFV-A10/-A15
- Standard type ZFV-A20/-A25

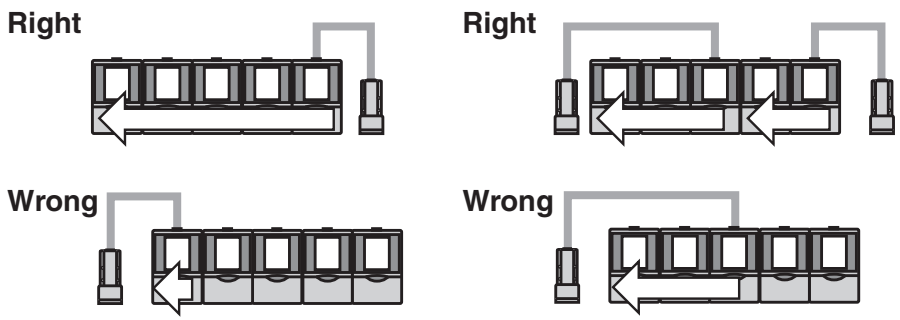
Power supply
DC24V (+10%, -15%)

Recommended OMRON power supply
(1) When 1 Amplifier Unit is connected
S82K-01524 (DC24V, 0.6A)
(2) When 2 or 3 Amplifier Units are connected
S82K-05024 (DC24V, 2.1A)
(3) When 4 or 5 Amplifier Units are connected
Prepare the required number of (1) and (2) power supplies above.

## ■ Application Expanded Configuration

Up to five Amplifier Units can be gang-mounted.
When the Amplifier Unit is gang-mounted, a wider range of applications can be supported as simultaneous processing of multiple areas and measurement items can be combined.

The image captured by the Sensor Head is transferred to the leftmost Amplifier Unit, so connect to the rightmost Amplifier Unit.



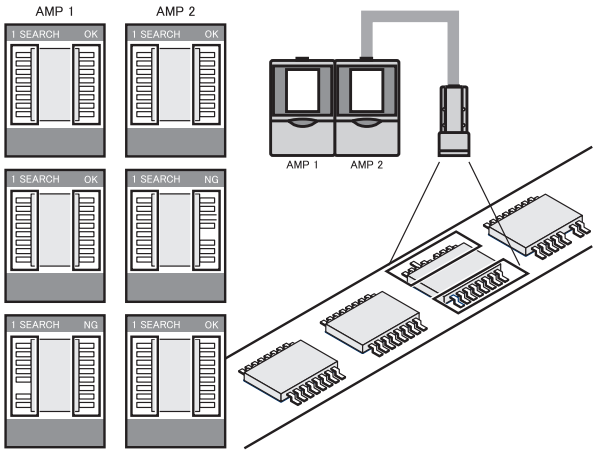

CHECK!

- The maximum number of Amplifier Units that can be connected is five regardless of the number of connected Sensor Heads.Six or more Amplifier Units cannot be connected.
- Provide power to all gang-mounted Amplifier Units.

## ● Example 1

In this configuration, multiple parts of an image from a single Sensor Head are measured and multiple inspection item are performed.

Example) Inspection of the number of leads

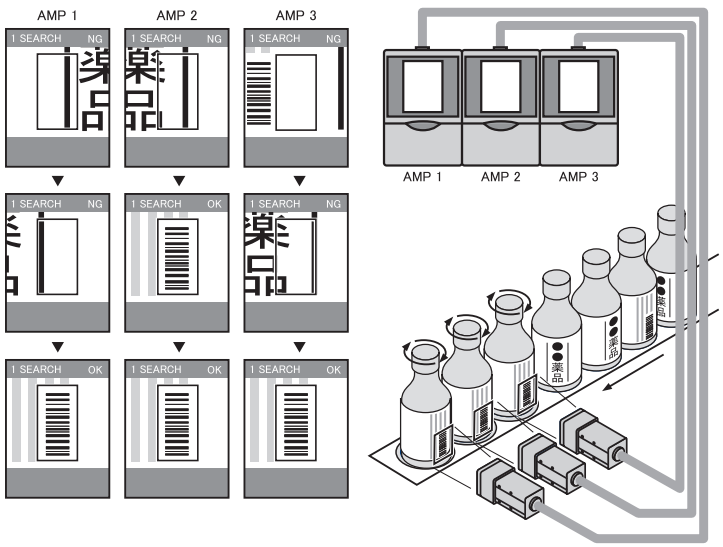



## ● Example 2

In this configuration, multiple Sensor heads are used to simultaneously inspect multiple locations on a workpiece.

When the TRIG signal is input from a single specified Amplifier Unit, the connected Amplifier Unit starts sensing immediately. The result of sensing is integrated on the Amplifier Unit to which the TRIG signal was input, and is output as a total judgment result.

Example) Alignment of products

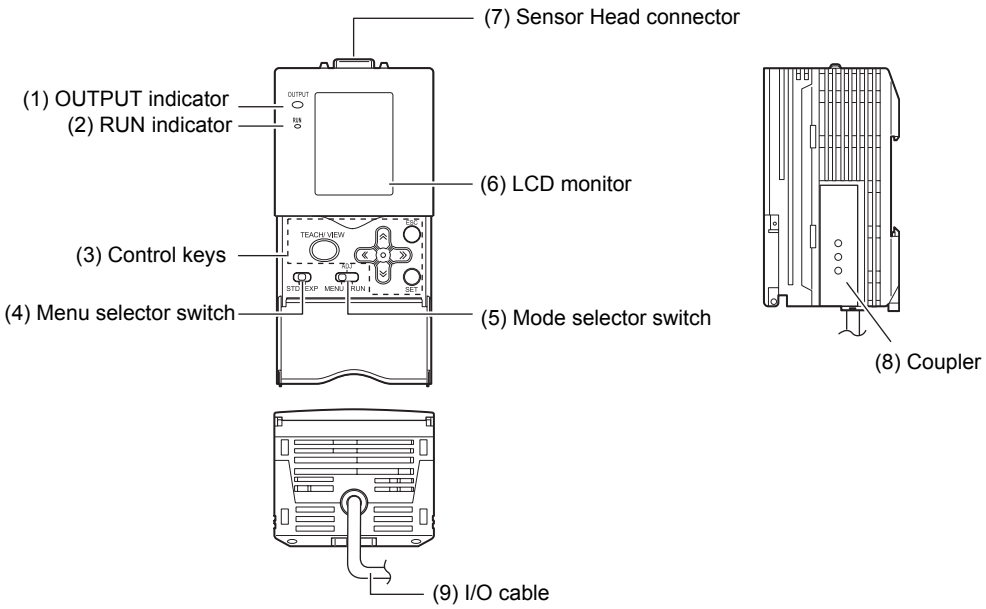


# Part Names and Functions



The following describes the names and functions of parts on the Amplifier Unit and Sensor Head.

## ■ Amplifier Unit




**(1) OUTPUT indicator**

The Output indicator lits when the OUTPUT signal turns ON.

**(2) RUN indicator**

The RUN indicator turns ON in the RUN mode.

**(3) Control keys**

The Control Keys are for setting measurement conditions and other information.

Displays and Key Operations p.45

**(4) Menu selector switch**

This switch selects the setup menu.

STD...Standard menu. Select this when setting the minimum required items for measurement.

EXP...Expert menu. Select this item when making a more detailed setup.

**(5) Mode selector switch**

This switch selects the operating mode.

MENU...Select this mode when setting measurement conditions.

ADJ...Select this mode when adjusting the judgment threshold value.

RUN...Select this mode when performing measurement.

Output is performed only when the RUN mode is currently selected.

**(6) LCD monitor**

The LCD monitor displays setup menus and images captured from the Sensor Head.

**(7) Sensor Head connector**

This connector connects the Sensor Head.

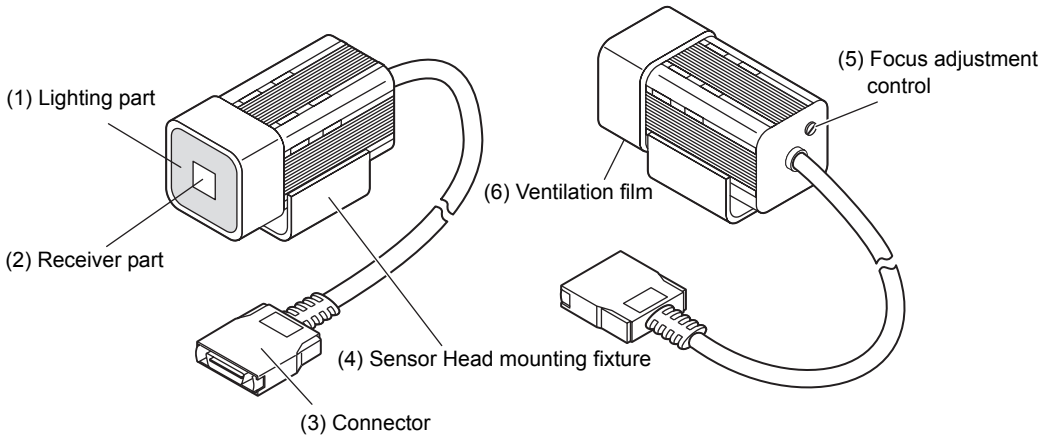
**(8) Coupler**

This connector is used to connect two or more Amplifier Units. It is located on both sides of the Amplifier Unit.

**(9) I/O Cable**

The I/O cable connects the Amplifier Unit to the power supply and external devices, such as timing sensors or programmable controllers.

## ■ Sensor Head




**(1) Lighting part**
This section emits light.

**(2) Receiver part**
This section captures the image.

**(3) Connector**
This connector is connected to the Amplifier Unit.

**(4) Sensor Head mounting fixture**
This fixture is for mounting the Sensor Head.
This fixture can be mounted on all of the four mounting surfaces.

**(5) Focus adjustment control**
This control is used for adjusting the focus of the image.

**(6) Ventilation film**
This film prevents the front panel from condensation.

# Section 2
# INSTALLATION & CONNECTION


About Installation and Connection 22

Amplifier Unit 23

- Attaching the ferrite core 23
- Installing the Amplifier Unit 23
- Gang mounting 27
- About the I/O cable 31
- Timing charts 34

Sensor Head 37

- Attaching the ferrite core 37
- Installing the mounting fixture 37
- Installing the Sensor Head 38
- Connecting the Sensor Head 40

# About Installation and Connection

## ■ Checking the installation environment

Read “Precautions for Safe Use” at the beginning of this manual, and check the installation environment.

## ■ Checking the installation site

Read “Precautions for Correct Use” at the beginning of this manual, and check the installation site.

## ■ About the power supply

Before installing and connecting the Smart Sensor, be sure to turn it OFF.
Also read “Precautions for Safe Use” and “Precautions for Correct Use” at the beginning of this manual, and check the power supply and wiring.

# Amplifier Unit

This section describes installation of the Amplifier Unit, and connection of the I/O cable.

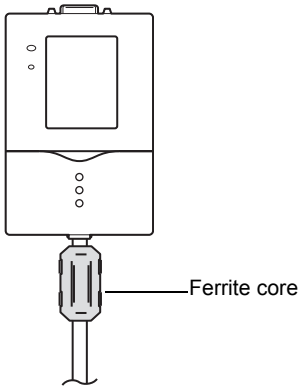
CHECK!

Before connecting/disconnecting peripheral devices, make sure that the Smart Sensor is turned OFF. The Smart Sensor may break down if the Smart Sensor is connected or disconnected while the power is ON.



## Attaching the ferrite core

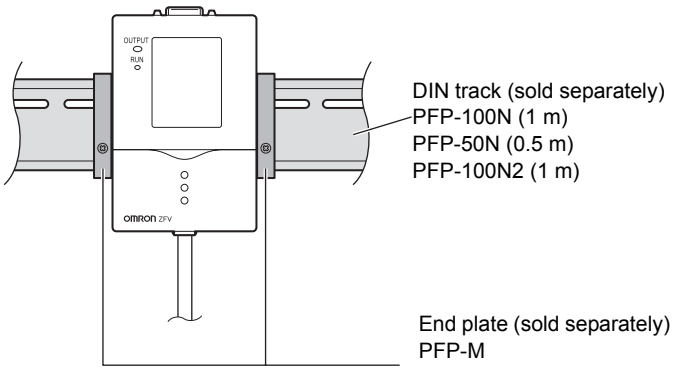
Attach the ferrite core (provided with the Smart Sensor) to the I/O cable of the Amplifier Unit.




## Installing the Amplifier Unit

### ■ Installing on the DIN track

Amplifier Units can be easily mounted on the 35-mm DIN track.

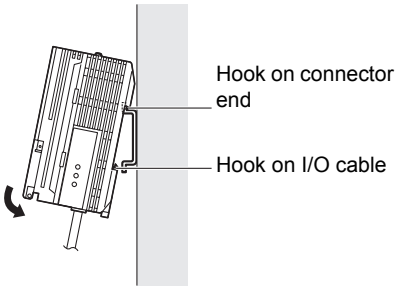


## ● Installation procedure

**1. Hook the connector end of the Amplifier Unit onto the DIN track.**

**2. Push the Amplifier Unit down onto the DIN track until the hook on the I/O cable side is locked.**

Push down until you hear it snap into place.




CHECK!

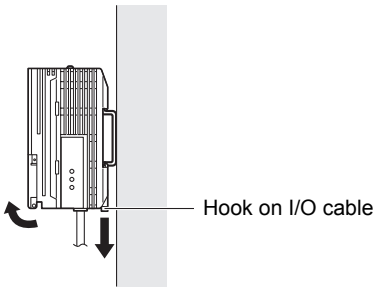
Always hook the connector end of the Amplifier Unit on the DIN track first. Hooking the I/O cable end on the DIN track first may impair the mounting strength of the DIN track attachment.

## ● Removal procedure

The following describes how to remove the Amplifier Unit from the DIN track.

**1. Pull the hook on the I/O cable end of the Amplifier Unit downwards.**

**2. Lift up the Amplifier Unit from the I/O cable end, and remove it from the DIN track.**

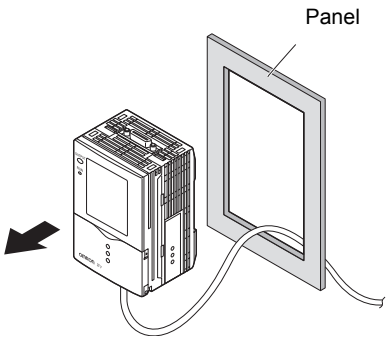


## ■ Mounting on a panel

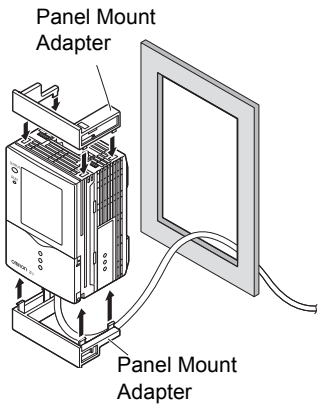
The Panel Mount Adapters (sold separately ZS-XPM1) can be used to mount the Amplifier Unit on a panel.

Panel Mount Adapters p.87

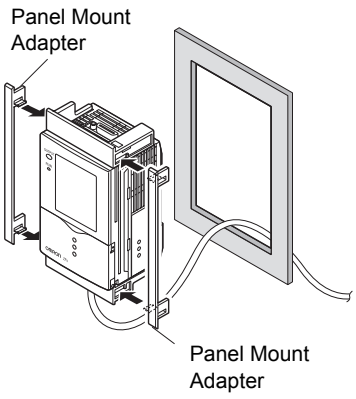
**1. Push out the Amplifier Unit from the rear of the panel towards the front.**




**2. Install the small Mount Adapters on the four holes on the Amplifier Unit.**

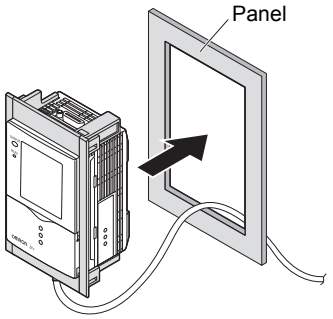



**3. Install the long Mount Adapters on the two holes on the small Mount Adapter.**

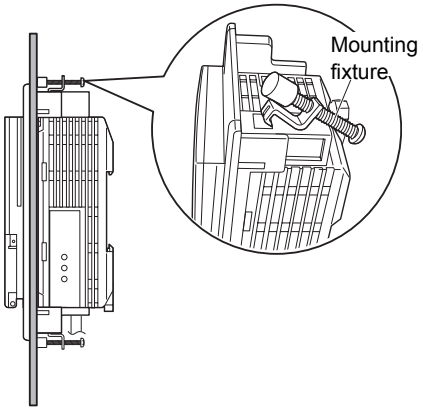


**4.** **Install the Amplifier Unit with Mount Adapters attached onto the panel from the front.**

CHECK! Take care not to pinch the I/O cable.




**5.** **Hook the hooks of the mounting fixture onto the two holes of the smaller Mount Adapters and tighten the screws.**




**6.** **Make sure that the Amplifier Unit is firmly fixed on the panel.**

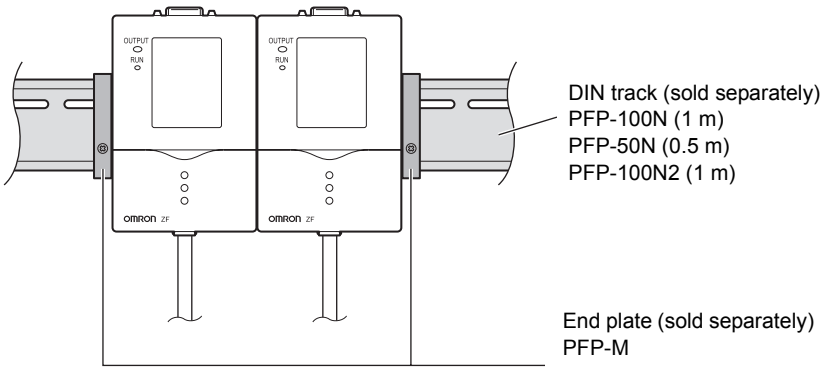
# Gang mounting

Up to five Amplifier Units can be gang-mounted.

Application Expanded Configuration p.16

## ■ Installing on the DIN track

Amplifier Units can be easily mounted on the 35-mm DIN track.




### ● Installation procedure

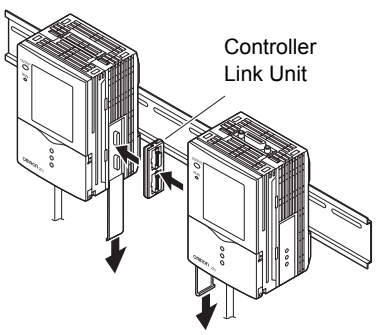
**1. Install Amplifier Unit on the DIN track.**

p.27

**2. Open the connector cover on the Amplifier Unit.**

Slide the cover to remove.

**3. Insert the Controller Link Unit into the connector on the Amplifier Unit.**




**4. Slide the Amplifier Unit, and insert into the connector on the Controller Link Unit.**

## ● Removal procedure

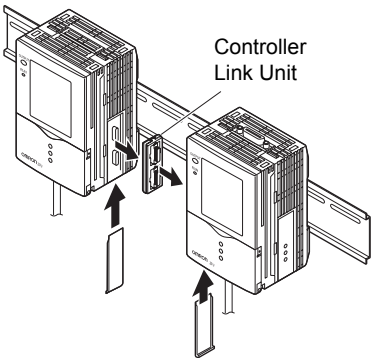
**1.** **Slide the Amplifier Unit, and remove from the connector on the Controller Link Unit.**

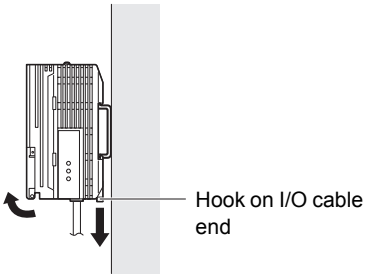
**2.** **Slide the Controller Link Unit and remove from the connector on the Amplifier Unit.**

**3.** **Install the cover on the coupler of the Amplifier Unit.**

**4.** **Pull the hook on the I/O cable end downwards.**

**5.** **Lift up the Amplifier Unit from the I/O cable end, and remove it from the DIN track.**



## ■ Mounting on a panel

The Panel Mount Adapters (sold separately ZS-XPM1/XPM2) can be used to mount the Amplifier Unit on a panel.

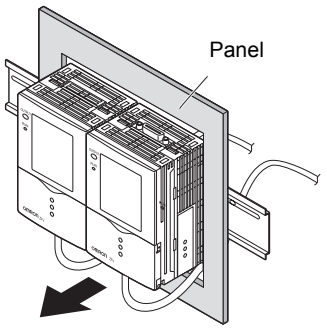
Panel Mount Adapters p.87

### 1. Install the Amplifier Unit on the DIN track.

p.27

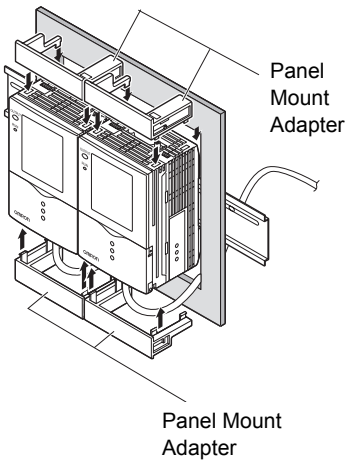
CHECK! When mounting on a panel, be sure to install the DIN track on the rear side of the Amplifier Unit for support.

### 2. Push out the Amplifier Unit from the rear of the panel towards the front.




### 3. Install the small Mount Adapters on the four holes on the Amplifier Unit.

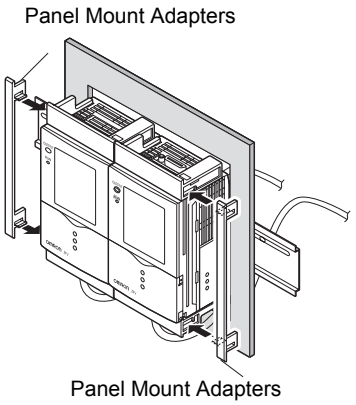
CHECK! Install the small Mount Adapters on all gang-mounted Amplifier Units.



**4. Install the long Mount Adapters on the two holes on the small Mount Adapter.**

CHECK!

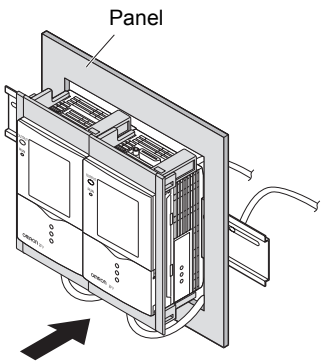
Install the long Mount Adapters only on both sides of gang-mounted Amplifier Units.




**5. Install the Amplifier Unit with Mount Adapters attached onto the panel from the front.**

CHECK!

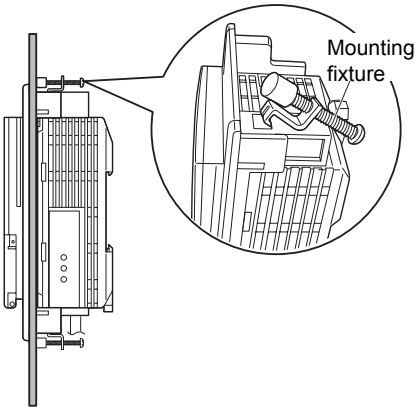
Take care not to pinch the I/O cable.




**6. Hook the hooks of the mounting fixture onto the two holes of the smaller Mount Adapters and tighten the screws.**

CHECK!

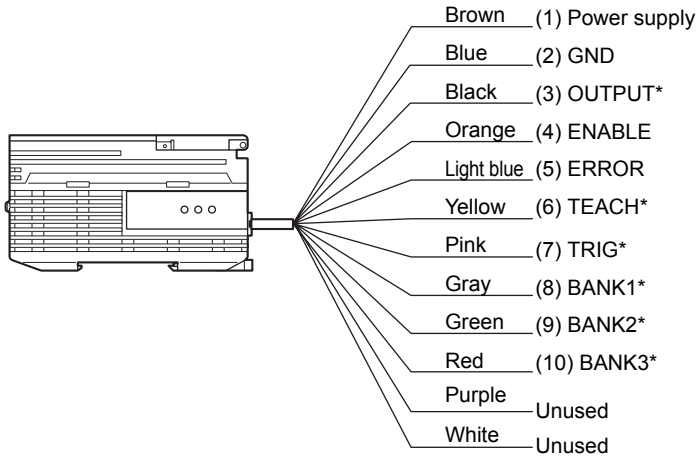
Attach two mounting fixtures each on all gang-mounted Amplifier Units.




**7. Make sure that the Amplifier Units are firmly fixed on the panel.**

# About the I/O cable

The following shows the leads that comprise the I/O cable.




* : Enabled only in the RUN mode

**(1) Power supply**

This connects the power supply.

Supply power from a DC power supply unit that has a countermeasure (safety ultra-low voltage circuit) built-in for preventing high voltages from occurring.

Recommended power supply unit p.16

Wire the power supply separately from other devices. Wiring them together or placing them in the same duct may cause induction, resulting in malfunction or damage.

**(2) GND**

The GND terminal is the 0V power supply terminal.

**(3) OUTPUT (control output)**

This outputs judgment results. This lead is interlocked with OUTPUT LED.

**(4) ENABLE (enable output)**

This turns ON when the sensor is ready for measurement.

**(5) ERROR (error output)**

This turns ON when an error is generated.

Error Messages and Remedies p.79

**(6) TEACH (teaching input)**

There are two teaching modes, workpiece stop teaching and workpiece move teaching. These teaching modes can be selected in the menu.

Selecting the teaching mode from an external device p.59

**(7) TRIG (measurement trigger input)**

There are two measurement modes, synchronous measurement and continuous measurement. Which mode of measurement is to be performed in is selected in the menu.

Selecting the measurement timing p.59

**(8) BANK1 (bank switching input 1)**

**(9) BANK2 (bank switching input 2)**

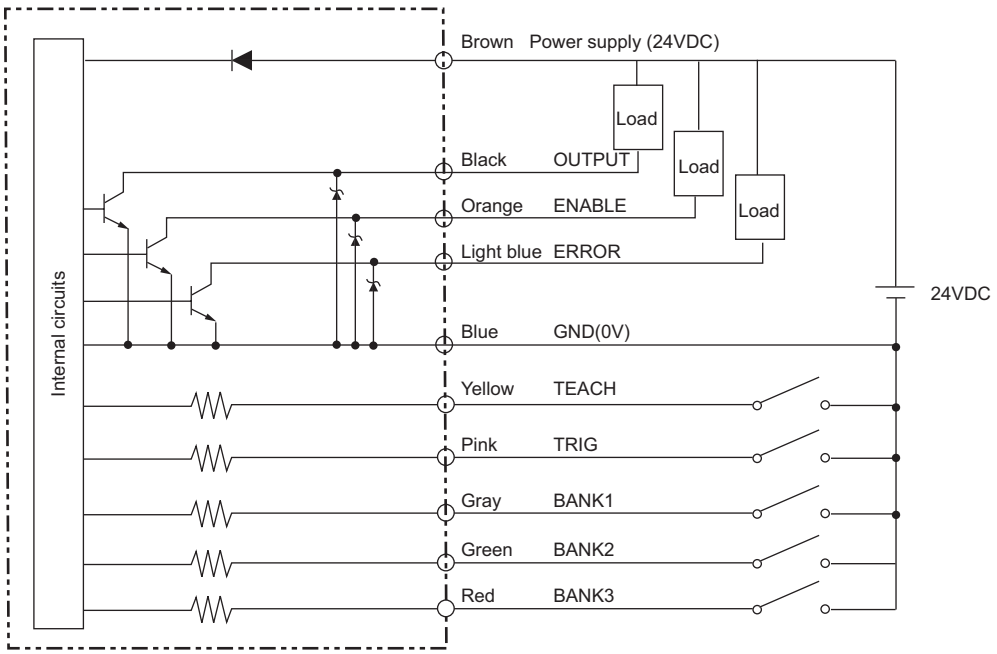
**(10) BANK3 (bank switching input 3)**

About bank switching

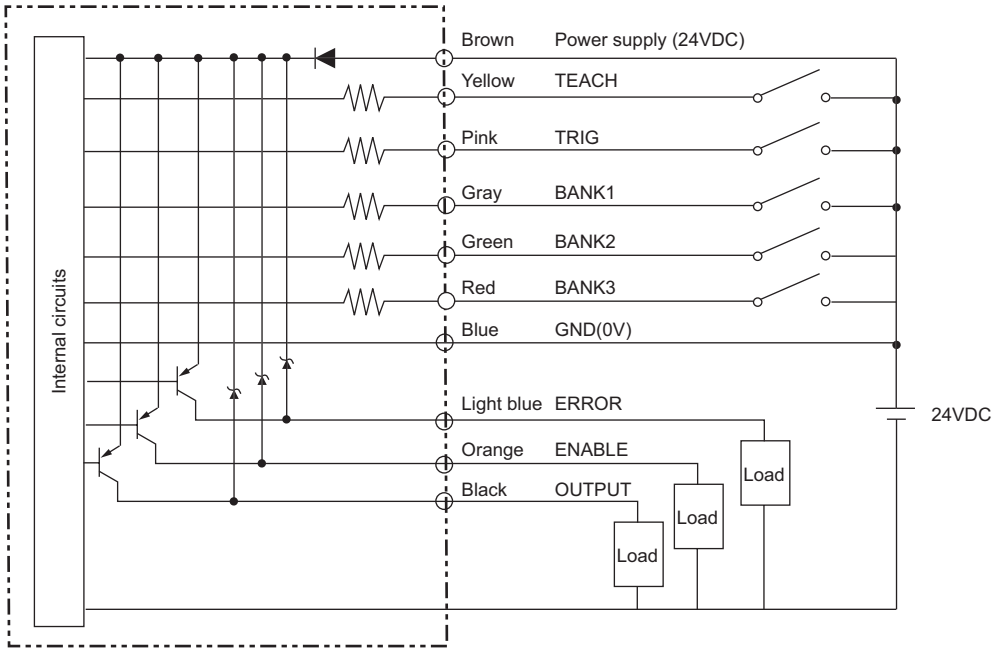
Timing charts p.34

## ■ I/O Circuit Diagrams

### ● NPN output type (ZFV-A10/A20)



## ● PNP output type (ZFV-A15/A25)



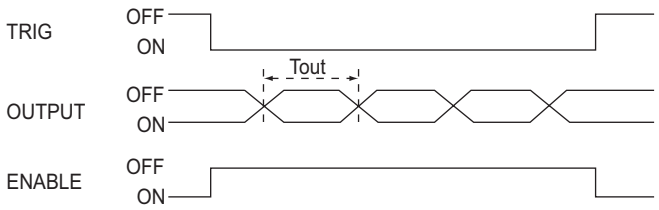
# Timing charts

The following shows the timing charts when communication is performed with external devices.

## ■ Measurement

### ● Continuous measurement

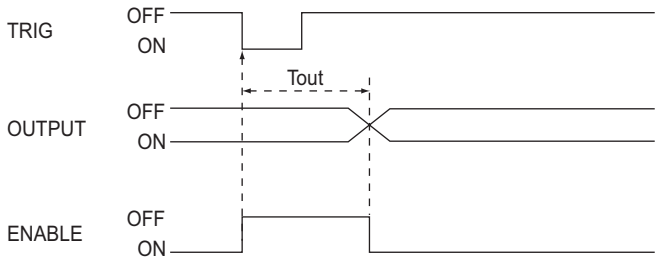
Measurement is performed continuously for the duration that the TRIG signal is ON. The measurement result is updated, and output to external devices at each measurement cycle.




Tout: Measurement cycle
The measurement cycle changes depending on the setting.

### ● Synchronous measurement

Measurement is performed only once in synchronous with the change in TRIG signal state from OFF to ON, and the result is output.




Tout: Measurement time.
The measurement time changes depending on the setting.

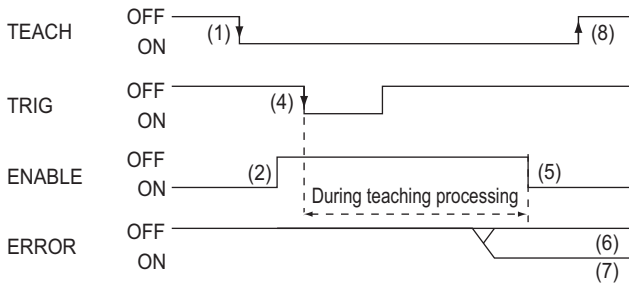
- The minimum ON width of the TRIG signal is 1 ms.
- The OUTPUT signal is held until the next measurement result is updated.
  Note, however, that when one-shot output is currently set, the OUTPUT signal is held for the preset time.

One-shot output p.61

# ■ Teaching

## ● Workpiece stop teaching

Teaching processing is performed according to TRIG signal input after the TEACH signal is input from the outside.
Measurement is not performed while teaching is being performed.
Do not move the workpiece until teaching is completed.




(1) Turn the TEACH signal ON.

(2) Confirm that the ENABLE signal has turned OFF.

(3) Make sure that the workpiece to be taught is in the teaching area.

(4) Input the TRIG signal from the outside.

(5) The ENABLE signal turns ON after teaching is completed. At this timing, check the state of the ERROR signal.

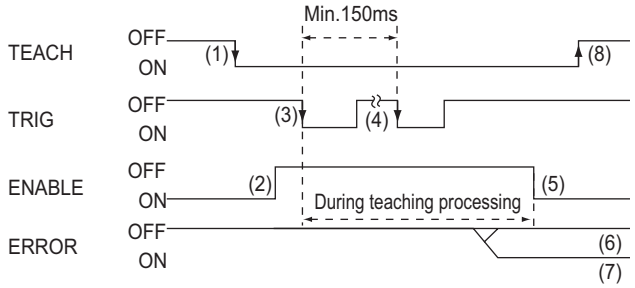
(6) When teaching has been completed successfully, the ERROR signal stays OFF.

(7) When teaching fails, the ERROR signal turns ON.

(8) Turn the TEACH signal OFF, and end teaching processing.
When teaching fails, the state before teaching was initiated is returned to. Perform teaching again.
If the TEACH signal is turned OFF midway, teaching is disabled.

## ● Workpiece move teaching

Use this teaching mode when the object cannot be stopped.
Teaching processing is divided up and performed in synchronous with the TRIG signal input after the TEACH signal is input from the outside.
Teaching must be processed six times.
Measurement is not performed while teaching is being performed.




(1) Turn the TEACH signal ON from the outside.

(2) Confirm that the ENABLE signal has turned OFF.

(3) Input the TRIG signal at the timing for measuring the workpiece to be taught.

(4) Repeat the input in step (3) six times. (Trigger inputs from the seventh time onwards are ignored.)

(5) The ENABLE signal turns ON after teaching is completed. Check the state of the ERROR signal at this timing.

(6) When teaching has been completed successfully, the ERROR signal stays OFF.

(7) When teaching fails, the ERROR signal turns ON.

(8) Turn the TEACH signal OFF, and end teaching processing.
When teaching fails, the state before teaching was initiated is returned to. Perform teaching again.
If the TEACH signal is turned OFF midway, teaching is disabled.

## ■ Bank switching

The bank No. can be switched when BANK1 to BANK3 are connected as follows.

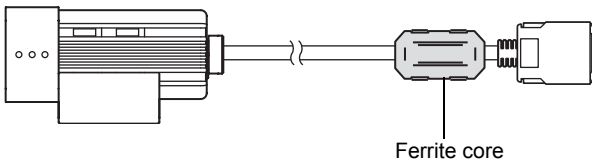
| Bank No. | BANK1 | BANK2 | BANK3 |
|---|---|---|---|
| BANK1 | OFF | OFF | OFF |
| BANK2 | ON | OFF | OFF |
| BANK3 | OFF | ON | OFF |
| BANK4 | ON | ON | OFF |
| BANK5 | OFF | OFF | ON |
| BANK6 | ON | OFF | ON |
| BANK7 | OFF | ON | ON |
| BANK8 | ON | ON | ON |

# Sensor Head

This section describes how to install and connect the Sensor Head.

## Attaching the ferrite core

Attach the ferrite core (provided with the Smart Sensor) to the connector side of the Sensor Head.

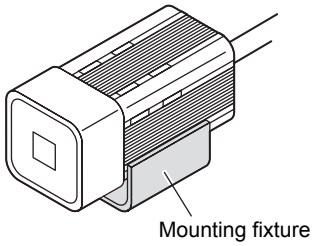



## Installing the mounting fixture

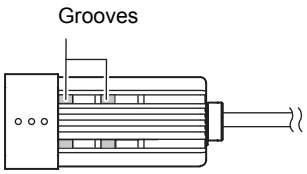
Attach the mounting fixture (provided with the Smart Sensor) to the side of the Sensor Head.

### ■ Installation procedure

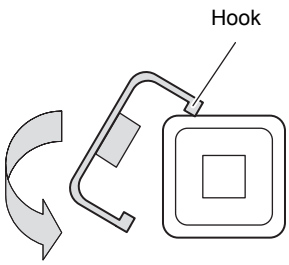
The mounting fixture can be installed on all of the four mounting surfaces.




**1. Align the two hooks on one side of the mounting fixture with the two grooves on the Sensor Head body (light emitting side).**



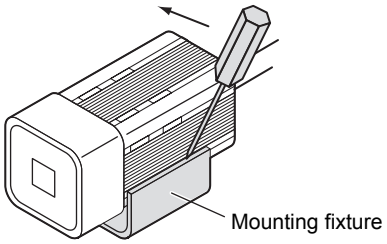

**2. Press in the other hook.**
Push down until you hear it snap into place.




**3. Make sure that the mounting fixture is firmly fixed on the Sensor Head.**

## ■ Removal procedure

Insert a regular screwdriver into the gap (one of the two gaps) between the mounting fixture and the Sensor Head case, and remove the mounting fixture.




# Installing the Sensor Head

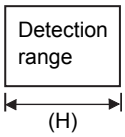
This section describes how to install the Sensor Head.
The detection range of the Sensor Head can be confirmed by the guide light. Install so that the part to be inspected is inside the frame formed by the guide light.

## ■ Installation distance

The following graphs show the relationship between detection range and setting distance for each model of Sensor Head.
Values differ according to each model of Sensor Head, so fully check the model before using these graphs.

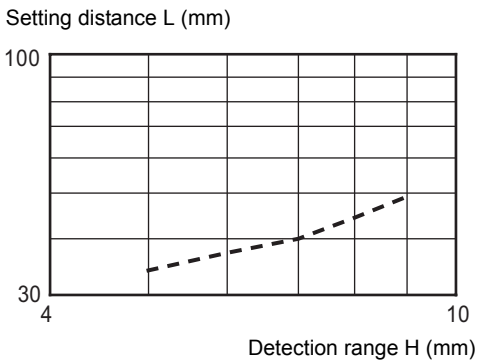
Reading graphs

"H" refers to the following width.



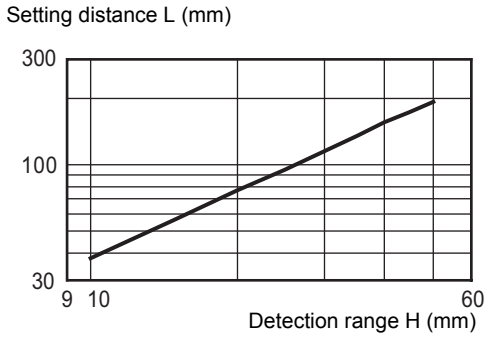

Details of detection range
p.84

• ZFV-SR10



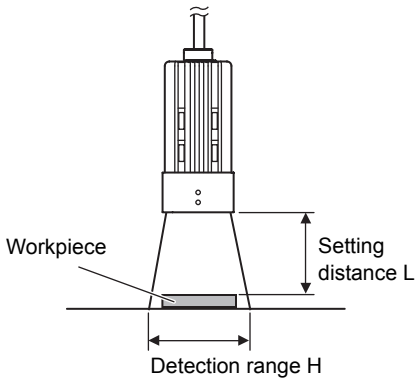

| Detection range H (mm) | Setting distance L (mm) |
|---|---|
| 5 | 34 |
| 6 | 37 |
| 7 | 40 |
| 8 | 44 |
| 9 | 49 |

• ZFV-SR50



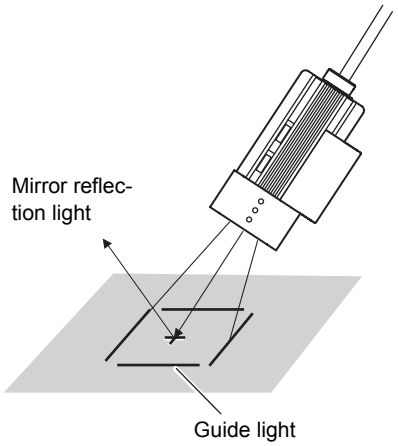

| Detection range H (mm) | Setting distance L (mm) |
|---|---|
| 10 | 38 |
| 15 | 57 |
| 20 | 76 |
| 25 | 95 |
| 30 | 115 |
| 35 | 134 |
| 40 | 157 |
| 45 | 174 |
| 50 | 194 |

(Example)
When using a ZFV-SR50 Sensor Head at a detection range of 25 mm required for the location of the sensing object, the setting distance of Sensor Head becomes 95mm.




## ● About installation for reflective workpieces

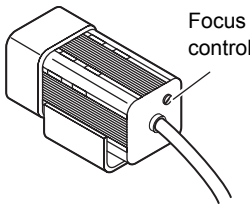
Install the Sensor Head at an angle to prevent mirror reflection light from being picked up by the sensor.



## ■ Installation procedure

**1. Install the Sensor Head at the installation distance obtained in the above graphs.**

**2. Turn the focus adjustment control to the left and right to adjust the focus.**




Focus can be verified by the green guide light.
Adjust so that the guide light is fine foned.
• Turn to right:Focuses to the far side.
• Turn to left:Focuses to the near side.
Default is focus set at furthest point.

CHECK!

Before turning the focus adjustment control slightly to the left and right, make sure that the guide light is not at the upper or lower limit positions. The focus adjustment control is a multi-turn variable resistor. However, the control stops turning at the upper or lower limit positions. Do not exert unnecessary force to turn the control at the upper or lower limit positions as this might damage the control.

# Connecting the Sensor Head

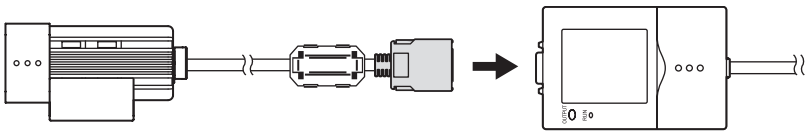
This section describes how to connect the Amplifier Unit.

CHECK!

- Before connecting/disconnecting the Sensor Head, make sure that the Amplifier Unit is turned OFF. The Sensor Head may break down if the Sensor Head is connected or disconnected while the power is ON.
- Do not touch the terminals inside the connector.

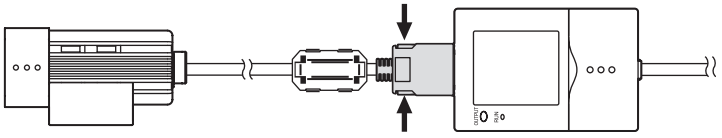
## ■ Connecting the Sensor Head

Insert the Sensor Head connector into the Sensor Head connector of the Amplifier Unit.



## ■ Disconnecting the Sensor Head

Pull out the Sensor Head while pressing in the hooks on both sides of the Sensor Head connector.



# Section 3
# SETUP


Setting Flow 42

About Setup 44

Basic Knowledge for Operation 44
List of Setting Items in MENU mode 46

Executing Teaching 48

Teaching Flow 48
Types of Teaching 49

Adjusting Threshold Values 53

Performing Measurement 57

Setting Banks 58

Switching banks 58
Copying banks 58
Clearing banks 58
Setting the bank switching method 58

Setting the System Environment 59

Adjusting the measurement speed 59
Selecting the measurement timing 59
Selecting the teaching mode from an external device 59
Setting/canceling the “Eco” mode 60
Initializing setup data 60
Checking the version 60

Changing the Input/output Conditions 61

Selecting the ON conditions 61
One-shot output 61
Setting the ON delay time 62
Setting the OFF delay time 63

Settings during application extended connection 63

Specifying the Amplifier Unit to input the trigger 64
Setting the presence of Sensor Head 64
Setting output content 64
Common items 65
PATTERN/SEARCH, MATCH 66
BRIGHT 67
AREA 68
WIDTH 69
POSITION 70
COUNT 71
CHARA/CHARA 1, CHARA 2 72

# Setting Flow

## Preparation for Measurement

### Installation and Connection

Set the Sensor Head and Amplifier Unit.

SECTION 2
INSTALLATION & CONNECTION p.22

Power ON

### Adjusting the Image

Adjust the focus of the image.

SECTION 2
INSTALLATION & CONNECTION p.40

## Setting of Measurement Conditions

(Only when Amplifier Units are gang-mounted)

### Settings in an application extended connection

Set the processing details for each Amplifier Units.

p.63

### Executing Teaching

Execute teaching, and register the judgement criteria.

p.48

### External I/O

Set how to output the measurement values.

p.61

## Applying Settings, Performing Measurement

### Adjusting threshold values

Adjust the threshold values for judging the measurement result.

p.53

### Perform Measurement

p.57

## Applied Use of Functions

### Setting Banks
Use multiple banks for changeover.
p.58

### Setting Up the System Environment
Adjusting the measurement speed p.59
Selecting the measurement timing p.59
Selecting the teaching mode from an external device p.59
Setting/canceling the “Eco” mode p.60

## Advanced Setup

### Changing the Input/Output Conditions
p.61

### Customizing Measurement Conditions
p.65

## Additional Functions

### Changing the display image
Change the details to display on the LCD monitor during measurement.
p.57

### Clearing all data
Initialize the Amplifier Unit.
p.60

### Checking the Version
Confirm the version of the Amplifier Unit.
p.60

## When a Problem Occurs

### The Smart Sensor does not operate correctly
Troubleshooting p.78

### An error message has appeared
Error Messages and Remedies p.79

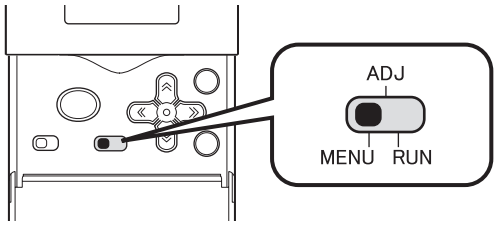
### If you have a query
Q&A p.80

# About Setup

## Basic Knowledge for Operation

### ■ Switching Modes

There are 3 operating modes as follows. Switch to the desired mode before you start operation. To switch the operating mode, use the mode switch.

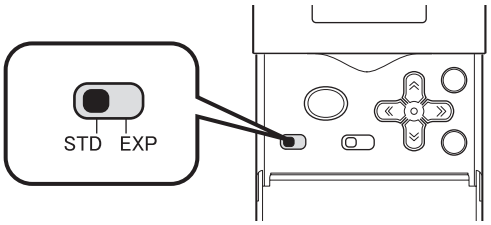



| Mode | Description |
|---|---|
| MENU mode | This mode is for executing teaching or setting up the measurement conditions. |
| ADJ mode | This mode is for setting the judgment threshold values. |
| RUN mode | This mode is for performing actual measurement. |

### ■ Switching Menus

There are two setup menus in the MENU mode. Switch the menu according to your specific requirements.

To switch the menu, use the menu selector switch.




| Setup Menu | Description |
|---|---|
| STD menu | This is the standard menu.<br>First, set the measurement conditions in this menu. |
| EXP menu | This is the expert menu.<br>Switch to this menu to make a more advanced setup. |

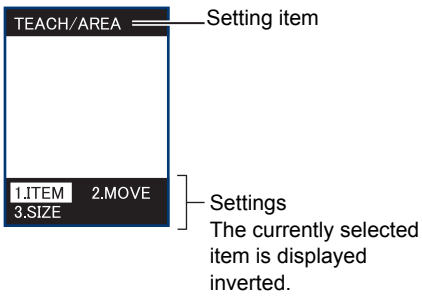
## ■ Displays and Key Operations

Make setups using the control keys while viewing the menus and the image displayed on the LCD monitor.

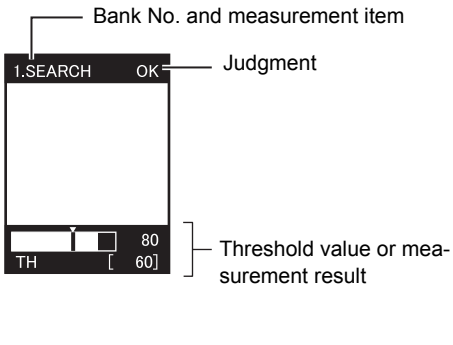
### ● Display

The details that are displayed differ according to the operating mode.

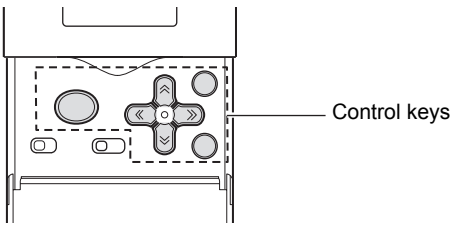
• MENU mode




• ADJ mode/RUN mode



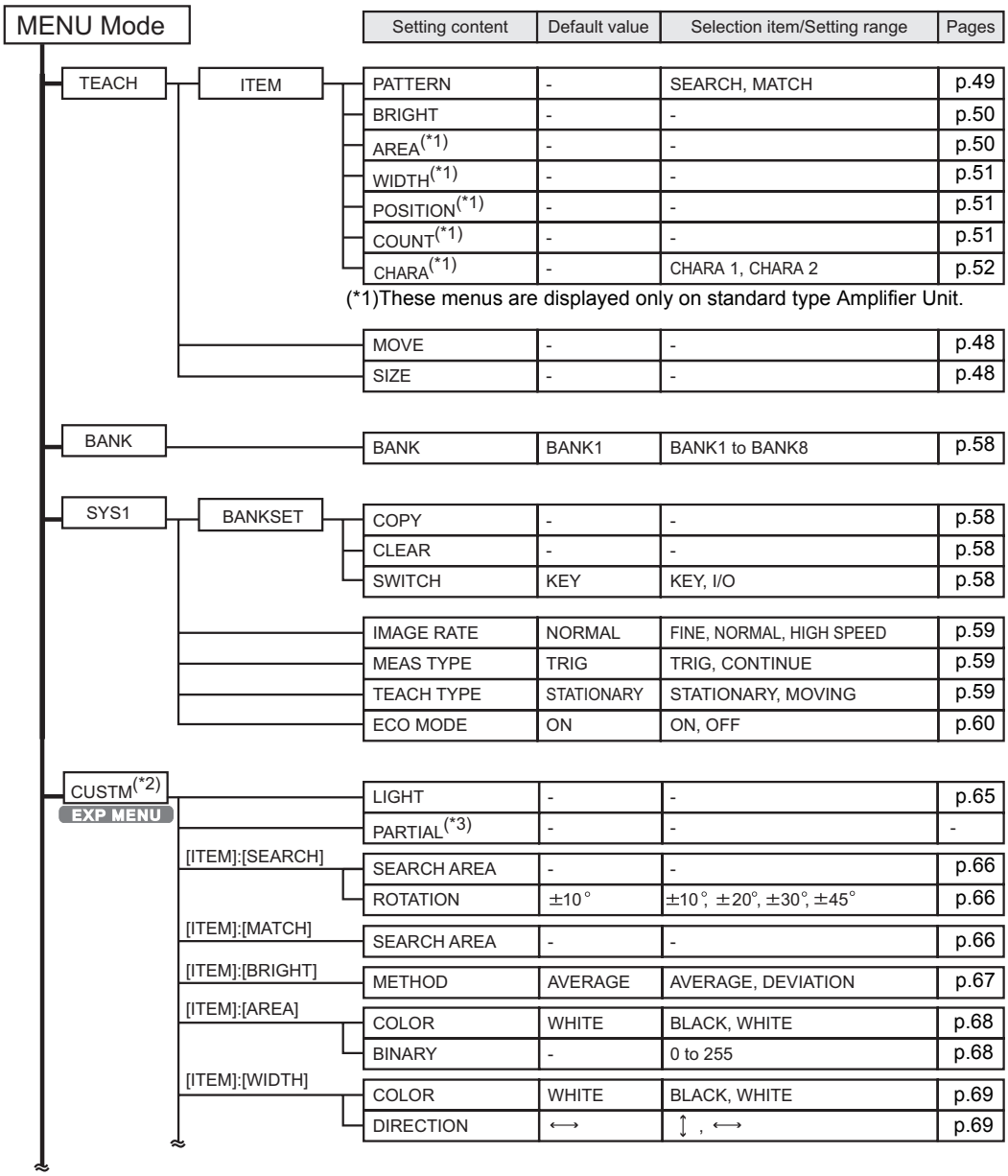

### ● Key Operations




| Key | | Description |
|---|---|---|
| ← LEFT key<br>→ RIGHT key | | The function of these keys differs according to the operating mode.<br>In MENU mode: Moves through menus.<br>In ADJ mode: Changes the adjustment item (type of threshold value).<br>In RUN mode: Changes the display details (type of measurement value). |
| ↑ UP key<br>↓ DOWN key | | The function of these keys differs according to the operating mode.<br>In MENU mode: Moves between menus, selects parameters, and sets numerical values.<br>In ADJ mode: Changes numerical values. |
| TEACH/VIEW key | | The function of these keys differs according to the operating mode.<br>In MENU mode: Executes teaching.<br>In RUN and ADJ modes: Switches the screen display. |
| SET key | | • Selects menus.<br>• Selects/applies items. |
| ESC key | | Returns to the previous menu. |

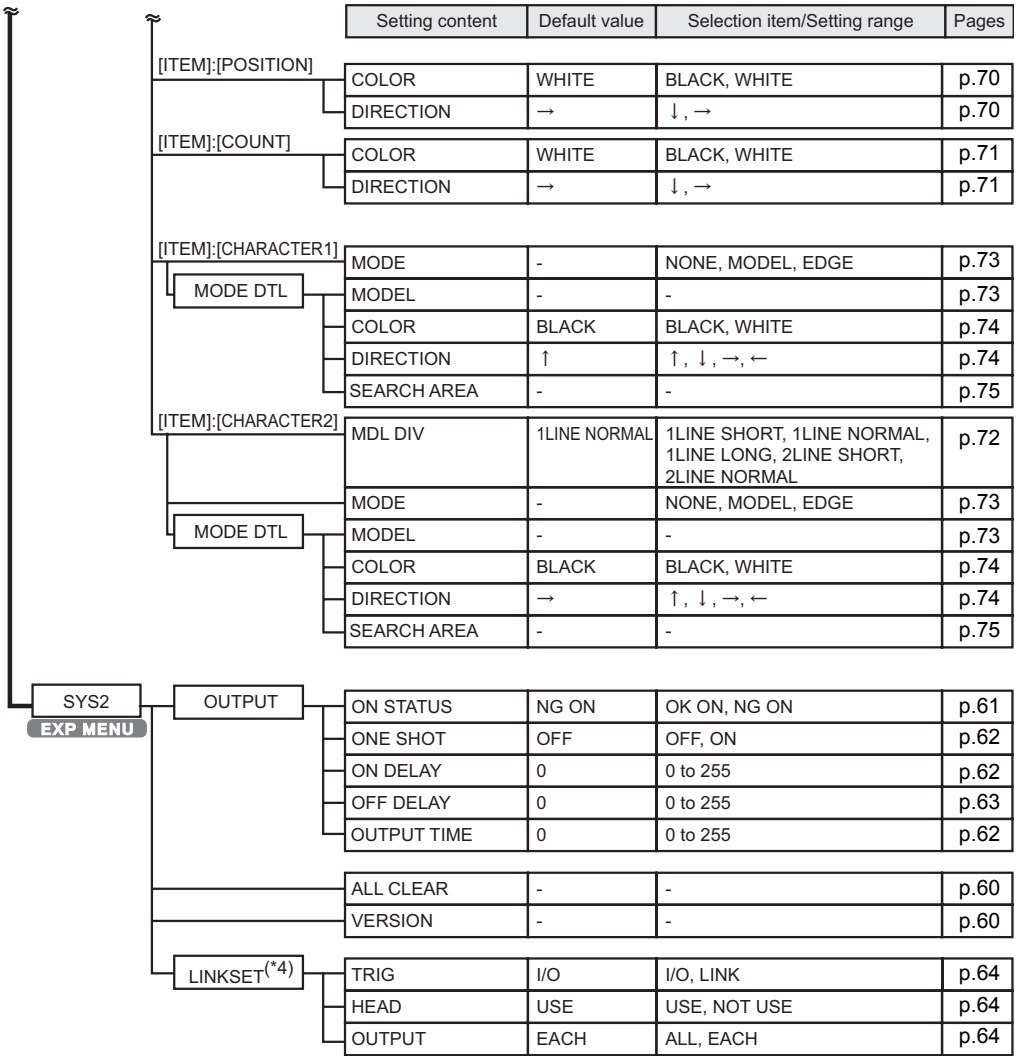
# List of Setting Items in MENU mode

The following shows the setting items in MENU mode
The details that are displayed differ according to the currently selected setup menu (STD or EXP). Switch the setup menu by the menu selector switch according to your specific requirements.



| MENU Mode | | Setting content | Default value | Selection item/Setting range | Pages |
|---|---|---|---|---|---|
| TEACH | ITEM | PATTERN | - | SEARCH, MATCH | p.49 |
| | | BRIGHT | - | - | p.50 |
| | | AREA(*1) | - | - | p.50 |
| | | WIDTH(*1) | - | - | p.51 |
| | | POSITION(*1) | - | - | p.51 |
| | | COUNT(*1) | - | - | p.51 |
| | | CHARA(*1) | - | CHARA 1, CHARA 2 | p.52 |
| | | (*1)These menus are displayed only on standard type Amplifier Unit. | | | |
| | | MOVE | - | - | p.48 |
| | | SIZE | - | - | p.48 |
| BANK | | BANK | BANK1 | BANK1 to BANK8 | p.58 |
| SYS1 | BANKSET | COPY | - | - | p.58 |
| | | CLEAR | - | - | p.58 |
| | | SWITCH | KEY | KEY, I/O | p.58 |
| | | IMAGE RATE | NORMAL | FINE, NORMAL, HIGH SPEED | p.59 |
| | | MEAS TYPE | TRIG | TRIG, CONTINUE | p.59 |
| | | TEACH TYPE | STATIONARY | STATIONARY, MOVING | p.59 |
| | | ECO MODE | ON | ON, OFF | p.60 |
| CUSTM(*2) EXP MENU | | LIGHT | - | - | p.65 |
| | | PARTIAL(*3) | - | - | - |
| | [ITEM]:[SEARCH] | SEARCH AREA | - | - | p.66 |
| | | ROTATION | ±10° | ±10°, ±20°, ±30°, ±45° | p.66 |
| | [ITEM]:[MATCH] | SEARCH AREA | - | - | p.66 |
| | [ITEM]:[BRIGHT] | METHOD | AVERAGE | AVERAGE, DEVIATION | p.67 |
| | [ITEM]:[AREA] | COLOR | WHITE | BLACK, WHITE | p.68 |
| | | BINARY | - | 0 to 255 | p.68 |
| | [ITEM]:[WIDTH] | COLOR | WHITE | BLACK, WHITE | p.69 |
| | | DIRECTION | ⟷ | ↕ , ⟷ | p.69 |

(*2)The display details of items from [CUSTOM] onwards differ according to the item selected at [ITEM].
(*3)This menu is displayed only when Sensor Head supporting partial scanning is connected.



| | Setting content | Default value | Selection item/Setting range | Pages |
|---|---|---|---|---|
| [ITEM]:[POSITION] | COLOR | WHITE | BLACK, WHITE | p.70 |
| | DIRECTION | → | ↓, → | p.70 |
| [ITEM]:[COUNT] | COLOR | WHITE | BLACK, WHITE | p.71 |
| | DIRECTION | → | ↓, → | p.71 |
| [ITEM]:[CHARACTER1] | MODE | - | NONE, MODEL, EDGE | p.73 |
| MODE DTL | MODEL | - | - | p.73 |
| | COLOR | BLACK | BLACK, WHITE | p.74 |
| | DIRECTION | ↑ | ↑, ↓, →, ← | p.74 |
| | SEARCH AREA | - | - | p.75 |
| [ITEM]:[CHARACTER2] | MDL DIV | 1LINE NORMAL | 1LINE SHORT, 1LINE NORMAL, 1LINE LONG, 2LINE SHORT, 2LINE NORMAL | p.72 |
| | MODE | - | NONE, MODEL, EDGE | p.73 |
| MODE DTL | MODEL | - | - | p.73 |
| | COLOR | BLACK | BLACK, WHITE | p.74 |
| | DIRECTION | → | ↑, ↓, →, ← | p.74 |
| | SEARCH AREA | - | - | p.75 |
| SYS2 EXP MENU / OUTPUT | ON STATUS | NG ON | OK ON, NG ON | p.61 |
| | ONE SHOT | OFF | OFF, ON | p.62 |
| | ON DELAY | 0 | 0 to 255 | p.62 |
| | OFF DELAY | 0 | 0 to 255 | p.63 |
| | OUTPUT TIME | 0 | 0 to 255 | p.62 |
| | ALL CLEAR | - | - | p.60 |
| | VERSION | - | - | p.60 |
| LINKSET(*4) | TRIG | I/O | I/O, LINK | p.64 |
| | HEAD | USE | USE, NOT USE | p.64 |
| | OUTPUT | EACH | ALL, EACH | p.64 |

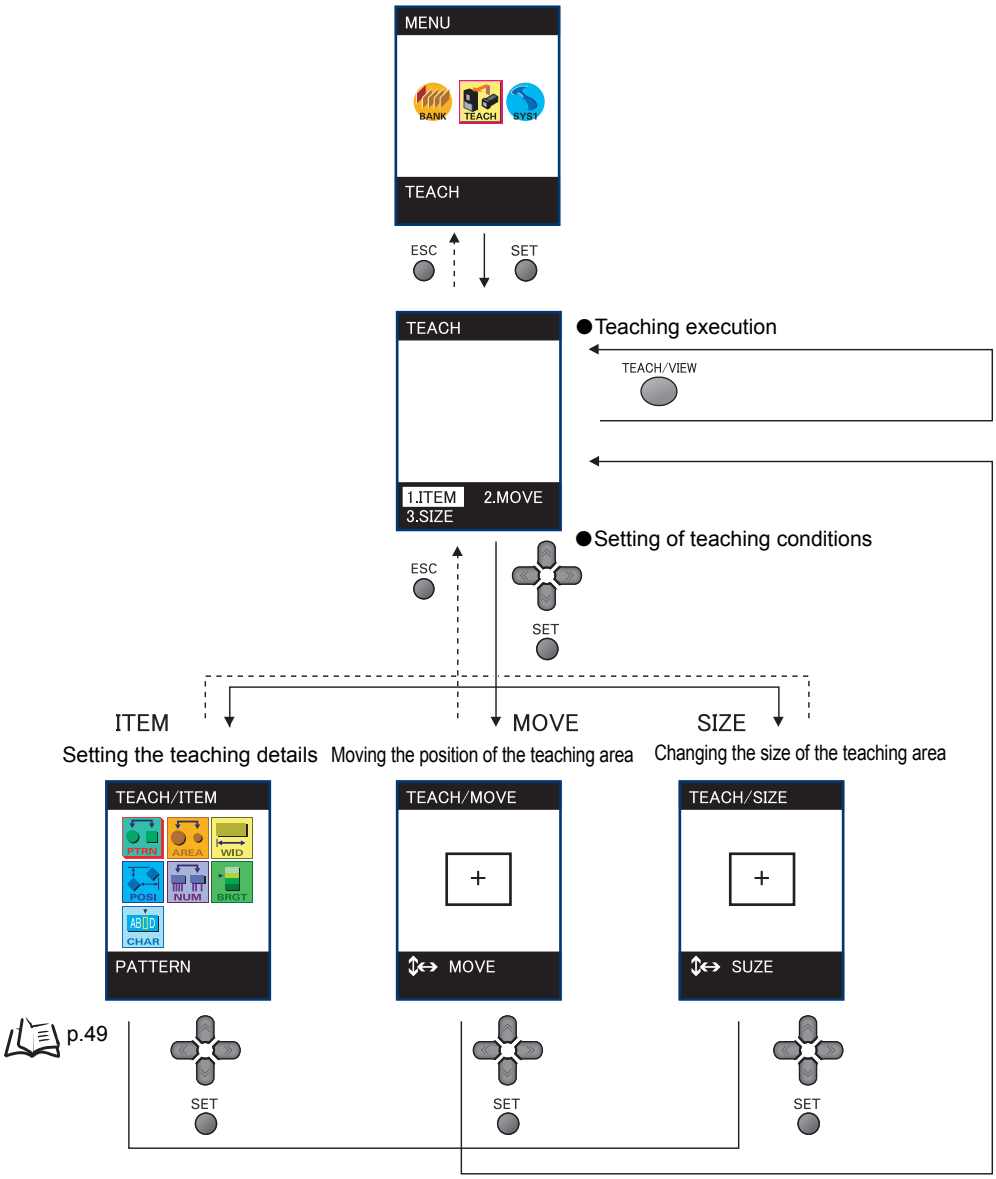
(*4)This menu is displayed only when Amplifier Units are gang-mounted.

# Executing Teaching

Execute teaching, and set the measurement conditions. Project the image to be used as the accepted image as the details set in teaching are used as the reference in judgment.

## Teaching Flow

There are two ways of executing teaching, by key operation and by external signals. The following shows a procedure for teaching by key operation.



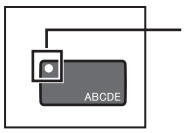
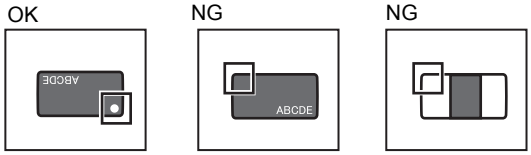
# Types of Teaching

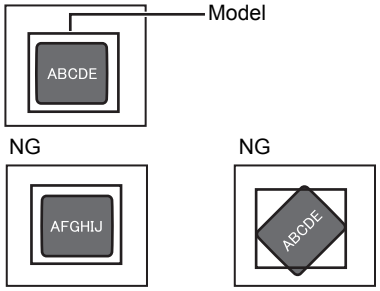
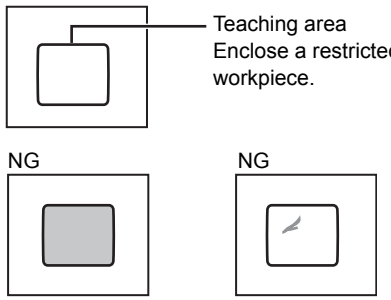
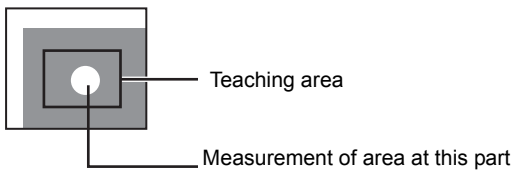
Select the type of teaching according to the detection content.
The details that are displayed differ according to the model of Amplifier Unit that you are using.

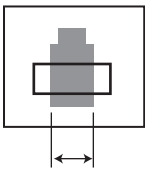
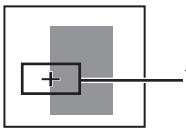
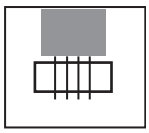
| Detection Content | Type of Teaching to Select | Pages |
|---|---|---|
| Pattern/shape/presence | PATTERN/SEARCH, MATCH | p.49, p.50 |
| Brightness/scratches, dirt | BRIGHT | p.50 |
| Size/area | AREA* | p.50 |
| Width | WIDTH* | p.51 |
| Position | POSITION* | p.51 |
| Number | COUNT* | p.51 |
| Characters | CHARA/CHARA 1, CHARA 2* | p.52 |

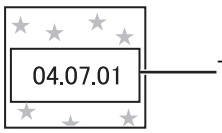
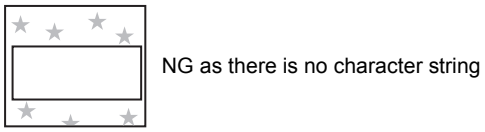
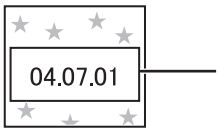
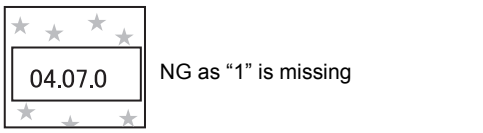
* : These items are displayed only when standard type Amplifier Unit is in use.

▶ MENU mode-[ITEM]

| Item | | Description | Example of Application |
|---|---|---|---|
| PATTERN | SEARCH | Select this item to detect the presence of a workpiece. This item supports workpieces tilted to an angle of ±45°. Teach the image pattern to be recognized, and register this pattern as a model. Judgment is performed by whether the registered model “is” or “is not” in the detected image.<br>Example) To recognize by the presence of a mark<br>Non-defective item<br>  <br>OK NG NG<br>  <br> <br>Measurement is unstable when there are two or more of the same pattern. Register unique patterns in the screen or restrict the search range.<br> Changing the search area p.75 | Detection of presence of sales campaign seals<br><br>Recognition of top/rear side and orientation of electronic components |

| Item | | Description | Example of Application |
|---|---|---|---|
| PATTERN | MATCH | Select this item for detecting shapes and recognizing different objects.<br>Judgment is performed by comparing the degree of match between a registered model and the target workpiece. Compared with [SEARCH], more detailed detection is possible, and larger workpieces can be detected. Note, however, that this item does not support tilted workpieces.<br>Non-defective item<br>  <br> <br>Measurement is unstable when there are two or more of the same pattern. Register unique patterns in the screen or restrict the search range.<br> Changing the search area p.75 | Recognition of different kind of instruction sheet |
| BRIGHT | | Select this item to detect brightness (density) or scratches/dirt on plain workpieces. Set the teaching area to the desired part of the workpiece to detect brightness in, and execute teaching.<br>Non-defective item<br>   | Detection of scratches/dirt in sheets<br>Checking of lighting of indicators |
| AREA* | | Select this item to recognize objects by size (area).Set the teaching area to the desired part of the workpiece to detect the size (area) in, and execute teaching.<br>   | Detection of presence of screw threads<br>Inspection of shortages in confectionary<br>Detection of presence of silver paste |

| Item | Description | Example of Application |
|---|---|---|
| WIDTH * | Select this item to detect width or interval.<br>Set the teaching area to the part of the workpiece to perform measurement in, and execute teaching.<br><br>Example) To measure width<br>  <br><br> <br>CHECK!<br>Set so that there are two changes in brightness in the detection area such as “light to dark” or “dark to light.” | Detection of lead width on capacitors or other electronic components<br>Detection of bent leads<br>Detection of out-of-position labels |
| POSITION* | Select this item to detect the position of a workpiece.<br>Set the teaching area to the part of the workpiece to perform measurement in, and execute teaching.<br>The edge of the workpiece is detected, and judgment is performed by comparing those edge coordinates against reference coordinates.<br><br>Example)<br>  <br><br> <br>CHECK!<br>Set so that there is one change in brightness in the detection area such as “light to dark” or “dark to light.” | Detection of out-of-position labels |
| COUNT* | Select this item when counting the number of workpieces.<br>Set the teaching area to the part of the workpiece to perform detection in, and execute teaching. The edges in the teaching area are detected, and judgment is performed by comparing the number of edges with a reference value.<br><br>Example) To detect the number of leads<br>  <br><br> <br>CHECK!<br>A change in brightness such as “light to dark to light” or “dark to light to dark” is counted as “1”. In the above example, the count is “4”. | Detection of the number of leads<br>Count of the number of cables |

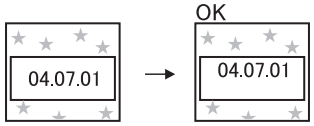
| Item | | Description | Example of Application |
|---|---|---|---|
| CHARA* | CHARA 1 | Select this item to detect the presence of an entire character string printed on a plain background.Judgment is performed by comparing the changes in density (brightness) of a registered character string. Omission of characters, errors, missing dots, etc. cannot be detected.   Example)   | Detection of presence of entire character string such as the “Best-before” date |
| | CHARA 2 | Select this item to detect omission of single characters. Errors in characters, missing dots, etc. cannot be detected.   Example)   | Detection of missing character in character strings such as the “Best-before” date |

* : This is displayed only when a standard type Amplifier Unit is in use.

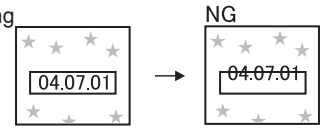
About the teaching area for [CHARA]

For the teaching area when the printing position is out of position, set to an area in which the character string might possibly be printed out of position. (Be sure, however, to set to an area having a plain background.)

If an area very close to the character string without any margin is set, the sensor will not be able to track any shift in the printing position.

Right  

Any shift of the printing position inside the teaching area is judged as OK.

Wrong  

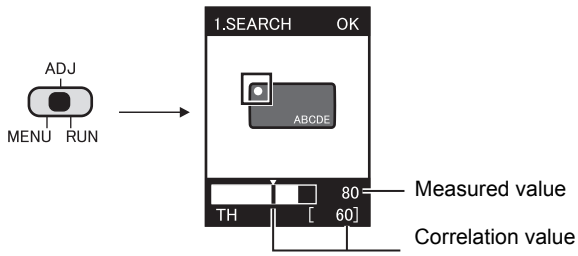
When the teaching area is set very close to the character without any margin, character protrudes from the teaching area and so this is judged as an NG.

# Adjusting Threshold Values

Threshold values are adjusted to determine the range for OK judgments.
Adjust the threshold values referring to the currently indicated measurement results. The adjustment details differ according to the currently set teaching mode.

## ■ SEARCH, MATCH

●Switch to ADJ Mode. ●Adjustment of correlation value

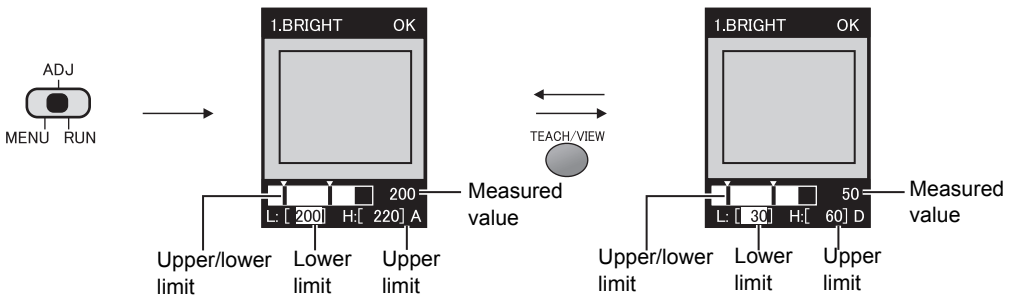



UP/DOWN keys: Change values.

| Setting item | Range | Details of Adjustment |
|---|---|---|
| Correlation value | 0 to 100 | This is the lower limit of the correlation value with the teaching model This value or above is judged as OK. |

## ■ BRIGHT

●Switch to ADJ Mode. ●Adjustment of average density value ●Adjustment of density deviation value



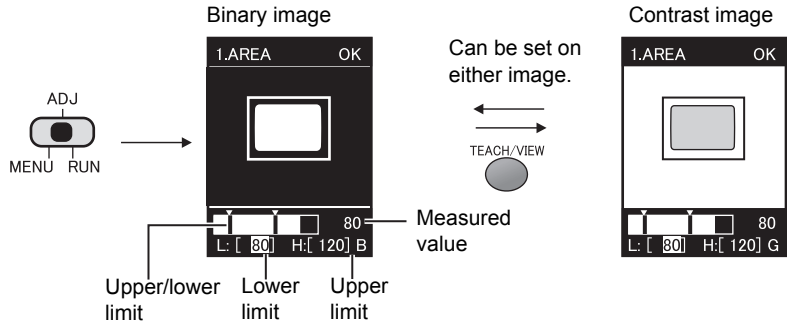

LEFT/RIGHT keys: Select upper limit/lower limit.
UP/DOWN keys: Change values.

LEFT/RIGHT keys: Select upper limit/lower limit.
UP/DOWN keys: Change values.

| Setting item | Range | Details of Adjustment |
|---|---|---|
| Average density value | 0 to 255 | This is the range of the average density inside the teaching area. |
| Density deviation value | 0 to 127 | This is the range of the density deviation inside the teaching area. |

## ■ AREA

●Switch to ADJ Mode. ●Adjustment of area value

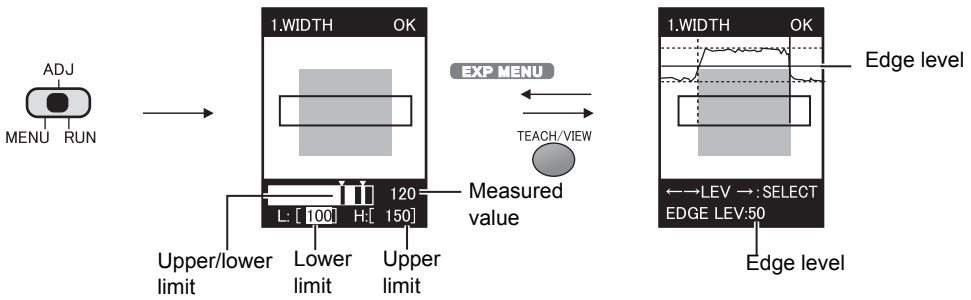



LEFT/RIGHT keys: Select upper limit/lower limit.
UP/DOWN keys: Change values.

| Setting item | Range | Details of Adjustment |
|---|---|---|
| Area value | 0 to 999 | This is the area in which OK is judged when the area value during teaching is taken to be 100%. |

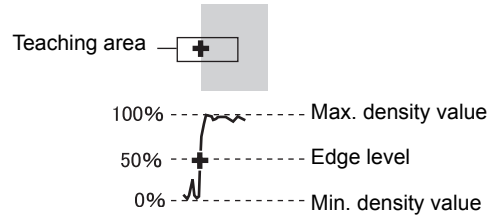
## ■ WIDTH

●Switch to ADJ Mode. ●Adjustment of edge width ●Adjustment of edge level



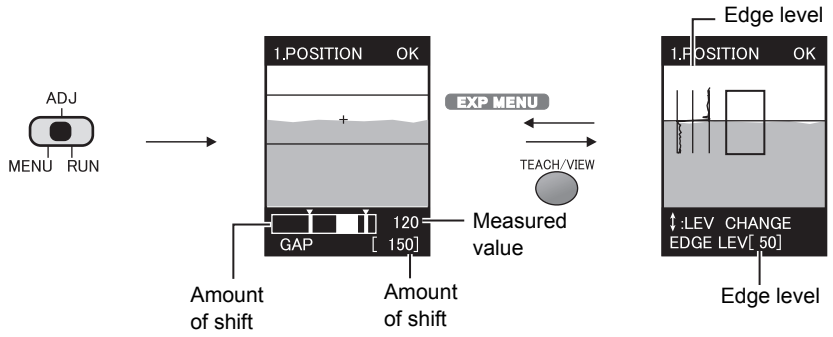

LEFT/RIGHT keys: Select upper limit/lower limit.
UP/DOWN keys: Change values.

- When edge detection direction is ←→
  LEFT/RIGHT keys: Switch edge.
  UP/DOWN keys: Change values.
- When edge detection direction is ↑ ↓
  UP/DOWN keys: Switch edge.
  LEFT/RIGHT keys: Change values.

| Setting item | Range | Details of Adjustment |
|---|---|---|
| Edge width | 0 to 999 | This is the area in which OK is judged when the width during teaching is taken to be 100%. |
| Edge level | 0 to 100 | This is the level of change in density judged to be an edge.<br>Adjust this level when measurement is unstable.<br>  |

## ■ POSITION

●Switch to ADJ Mode. ●Adjustment of edge position ●Adjustment of edge level



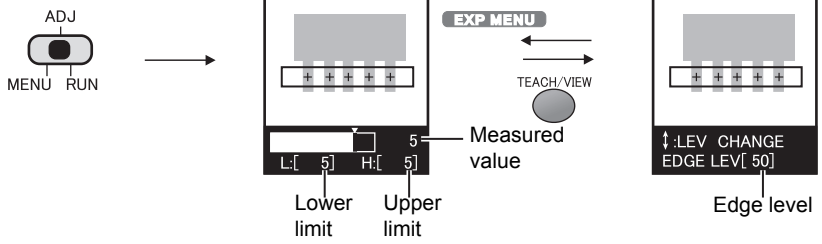

UP/DOWN keys: Change values.

- When edge detection direction is →
  UP/DOWN keys: Change values.
- When edge detection direction is ↓
  LEFT/RIGHT keys: Change values.

| Setting item | Range | Details of Adjustment |
|---|---|---|
| Position | 0 to 234 | Amount of shift from reference position |
| Edge level | | This is the level of change in density judged to be an edge. Adjust this level when measurement is unstable. p.54 |

## ■ COUNT

●Switch to ADJ Mode. ●Adjustment of number ●Adjustment of edge level

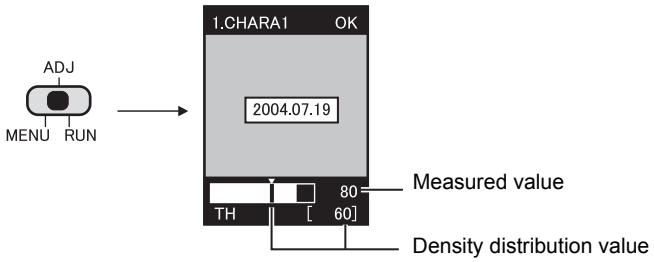



UP/DOWN keys: Change values.

| Setting item | Range | Details of Adjustment |
|---|---|---|
| Number | 0 to 128 | This is the number of times that counting is to be performed. |

## ■ CHARA 1

●Switch to ADJ Mode. ●Adjustment of correlation value

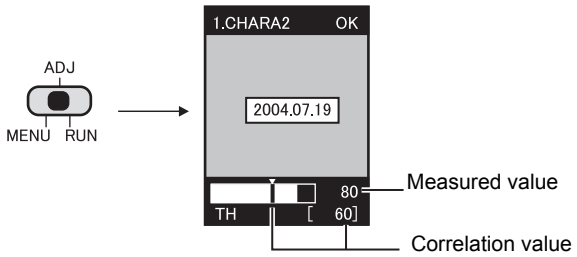



UP/DOWN keys: Change values.

| Setting item | Range | Details of Adjustment |
|---|---|---|
| Density distribution value | 0 to 100 | This is the value that is judged as OK when the density deviation value during teaching is taken to be 100%. |

## ■ CHARA 2

●Switch to ADJ Mode. ●Adjustment of correlation value




UP/DOWN keys: Change values.

| Setting item | Range | Details of Adjustment |
|---|---|---|
| Correlation value | 0 to 100 | This is the lower limit of the correlation value with the teaching model. This value or above is judged as OK. |

# Performing Measurement

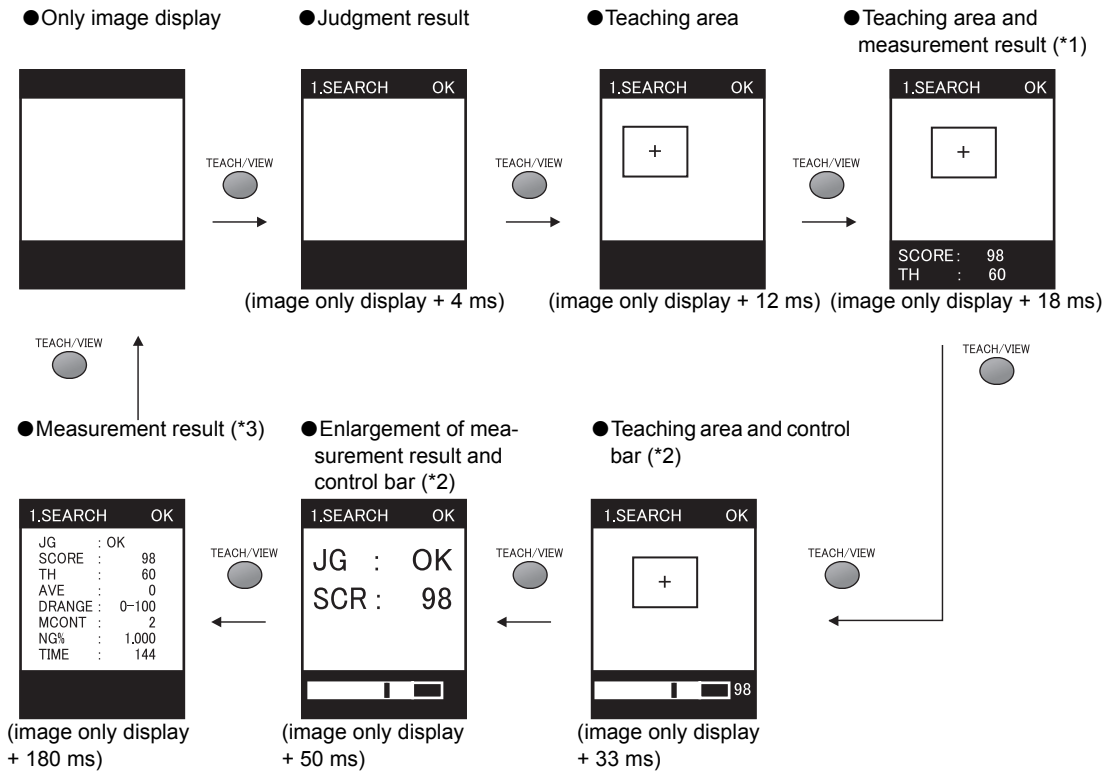
When the mode is switched to the RUN mode, measurement is executed, and the measurement result is output to the external device.

## ■ Switching the display during measurement

The display details are switched by pressing the TEACH/VIEW key during measurement.

CHECK!

The measurement time differs according to the type of display image. The measurement time for "only image display" is the fastest. The number in parentheses ( ) serves as a guideline when "only image display" is taken as the reference.
When the image is switched during measurement, the measurement time changes. For this reason, monitor the ENABLE signal, wait for the ENABLE signal to turn ON, and then input the TRIG signal.




(*1): In the case of [BRIGHT], the display can be switched (average density value, density distribution value) by the LEFT/RIGHT keys.
In the case of [AREA], the display can be switched to binary image by the LEFT/RIGHT keys.
(*2): The control bar shows the measurement result and judgment threshold value.
(*3): The measurement time (TIME) indicated here is the shortest measurement time in "only image display."

CHECK!

About meaning of display details in measurement results
p.81

# Setting Banks

The ZFV Series can hold up to eight sets of settings. These settings can be switched externally when changing the device setup
A set of these settings is called a “bank.”

## Switching banks

BANK 1 is selected as the default. BANK 2 and 8 are also available.

BANKs can also be switched from an external device.

Setting the bank switching method p.58

▶ MENU mode-[BANK]

| Setting | Description |
|---|---|
| BANK 1 to BANK 8<br>(default value: BANK 1) | Selects the target bank. |

## Copying banks

Copy the settings of other bank numbers to an already selected bank number.

▶ MENU Mode-[SYS1]-[BANKSET]-[COPY]

## Clearing banks

“Clearing” deletes the settings of the currently selected bank number.

▶ MENU Mode-[SYS1]-[BANKSET]-[CLEAR]

[SYS1], [SYS2] settings and RUN Mode display settings cannot be cleared.

## Setting the bank switching method

Select how to switch banks.

▶ MENU Mode-[SYS1]-[BANKSET]-[SWITCH]

| Setting | Description |
|---|---|
| KEY (default value) | Banks are switched by the control keys on Amplifier Unit. |
| I/O | Banks are switched by the control keys on Amplifier Unit and by external signals.<br>Switching by external signals is enabled only in the RUN mode. |

# Setting the System Environment

## Adjusting the measurement speed

Set the resolution of the input image.
Change the resolution according to the required precision and speed of measurement.

▶ MENU Mode-[SYS1]-[IMAGE RATE]

| Setting | Description |
|---|---|
| FINE | Select this when performing measurement by a high-precision image. Note, however, that it takes longer to perform measurements. |
| NORMAL (default value) | Standard |
| HIGH SPEED | Select this to perform high-speed measurement. Note, however, that images are rougher. |

## Selecting the measurement timing

Set the timing that measurement is executed.

▶ MENU Mode-[SYS1]-[MEAS TYPE]

| Setting | Description |
|---|---|
| TRIG (default value) | Synchronous measurement<br>Measurement is performed in synchronous with the change in state of the external TRIG signal from OFF to ON. |
| CONTINUE | Continuous measurement<br>Measurement is repeatedly performed for the duration that the TRIG signal is ON. |

## Selecting the teaching mode from an external device

There are two teaching modes from an external device.

▶ MENU Mode-[SYS1]-[TEACH TYPE]

| Setting | Description |
|---|---|
| STATIONARY (default) | Teaching is performed with the workpiece in a stationary state. Input of the external trigger input is required for teaching. |
| MOVING | The workpiece is moved when performing teaching.<br>Select this teaching mode only when the workpiece cannot be stopped.<br>Input of the external trigger is required for teaching. |

Timing charts p.34

## Setting/canceling the “Eco” mode

Whether or not to darken the screen when a preset time has passed without any operation. We recommend setting this mode to [ON] to prevent the brightness of the LCD screen from being impaired.

▶ MENU Mode-[SYS1]-[ECO MODE]

| Setting | Description |
|---|---|
| ON (default value) | Sets the “Eco” mode.<br>The screen darkens when three minutes continue without any operation. |
| OFF | Cancels the “Eco” mode setting. |



## Initializing setup data

EXP MENU

Return all bank settings and system settings to their factory settings.

CHECK!

The settings of all banks and system settings are initialized regardless of the currently selected bank No.

▶ MENU Mode-[SYS2]-[ALL CLEAR]

| Setting | Description |
|---|---|
| EXECUTE | Initializes the setup data. |
| CANCEL | Does not initialize the setup data. |

## Checking the version

EXP MENU

Displays the type of Sensor Head, type of Amplifier Unit and version information of the software.

▶ MENU Mode-[SYS2]-[VERSION]

# Changing the Input/output Conditions

## Selecting the ON conditions

EXP MENU

Set whether to turn the OUTPUT signal ON when OK is judged or when NG is judged.

▶ MENU Mode-[SYS2]-[OUTPUT]-[ON STATUS]

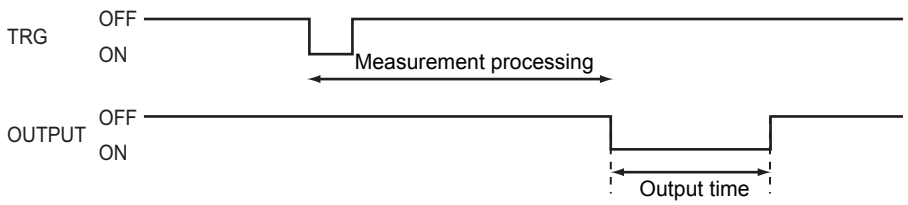
| Setting | Description |
|---|---|
| OK ON | Turns the OUTPUT signal ON when OK is judged. |
| NG ON (default value) | Turns the OUTPUT signal ON when NG is judged. |

## One-shot output

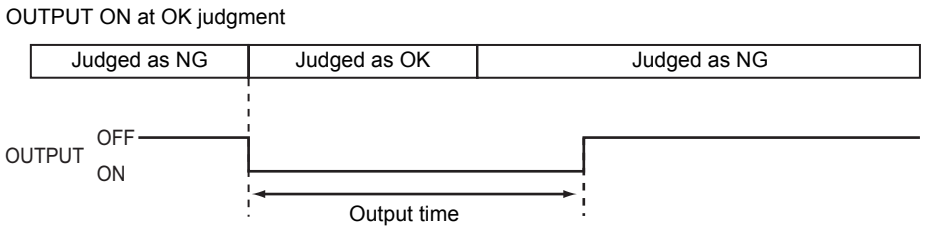
EXP MENU

OUTPUT turns ON for only the preset output time from when the OUTPUT signal turns ON.

### ● Synchronous measurement




### ● Continuous measurement



## ■ Selecting one-shot output ON/OFF

Set whether or not to enable one-shot output on the OUTPUT signal.

▶ MENU Mode-[SYS2]-[OUTPUT]-[ONE SHOT]

| Setting | Description |
|---|---|
| OFF (default value) | One-shot output is not performed. |
| ON | One-shot output is performed. |

CHECK!

When one-shot output is set to [ON], the OFF delay time setting is disabled.

## ■ Setting the one-shot output time

EXP MENU

OUTPUT turns ON for the preset time from when the OUTPUT signal turns ON.
This setting is valid only when [ONE SHOT] is set to [ON].

▶ MENU Mode-[SYS2]-[OUTPUT]-[OUTPUT TIME]

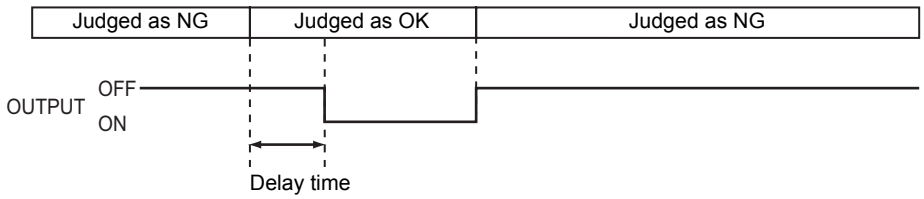
| Setting | Description |
|---|---|
| 0 to 255 (default value:0) | Set the time (ms) that OUTPUT is turned ON. |

# Setting the ON delay time

EXP MENU

Set this item to delay the timing that the OUTPUT signal turns ON.

OUTPUT ON at OK judgment in continuous measurement




▶ MENU Mode-[SYS2]-[OUTPUT]-[ON DELAY]

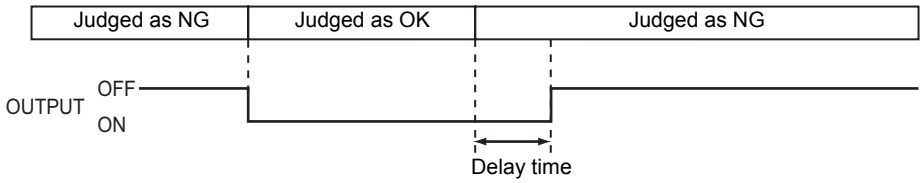
| Setting | Description |
|---|---|
| 0 to 255 (default value:0) | Set the time (ms) to delay turning ON of the OUTPUT signal. |

## Setting the OFF delay time

EXP MENU

Set this item to delay the timing that the OUTPUT signal turns OFF.

OUTPUT ON at OK judgment in continuous measurement




▶ MENU Mode-[SYS2]-[OUTPUT]-[OFF DELAY]

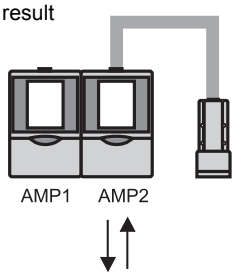
| Setting | Description |
|---|---|
| 0 to 255 (default value:0) | Set the time (ms) to delay turning OFF of the OUTPUT signal. |



# Settings during application extended connection

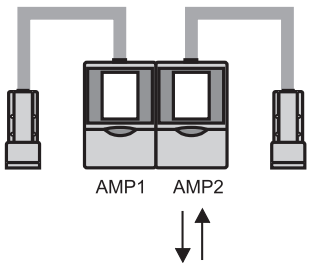
These menus are displayed only when Amplifier Units are gang-mounted.
Set to the all gang-mounted Amplifier Units.

Example 1)
AMP2: TRIG signal input, AMP2: Output of overall judgment result




| MENU | AMP1 | AMP2 |
|---|---|---|
| TRIG | LINK | I/O |
| HEAD | NOTUSE | USE |
| OUTPUT | — | All |

Example 2)
AMP2: TRIG signal input, AMP2: Output of overall judgment result




| MENU | AMP1 | AMP2 |
|---|---|---|
| TRIG | LINK | I/O |
| HEAD | USE | USE |
| OUTPUT | — | All |

## Specifying the Amplifier Unit to input the trigger

EXP MENU

Set whether or not to input the TRIG signal to an Amplifier Unit.

▶ MENU Mode-[SYS2]-[LINKSET]-[TRIG]

| Setting | Description |
|---|---|
| I/O (default value) | Set to only the Amplifier Unit to which the TRIG signal is to be input. |
| LINK | Synchronizes to the TRIG signal from the Amplifier Unit gang-mounted on the right side. |



## Setting the presence of Sensor Head

EXP MENU

Set whether or not a Sensor Head is connected.

▶ MENU Mode-[SYS2]-[LINKSET]-[HEAD]

| Setting | Description |
|---|---|
| USE (default value) | Select this for Amplifier Unit to which a Sensor Head is currently connected. Measurement is performed using the input image from the currently connected Sensor Head. |
| NOT USE | Select this for Amplifier Unit to which a Sensor Head is currently not connected. Measurement is performed from the image transferred from the Sensor Head gang-mounted on the right side. |

## Setting output content

EXP MENU

Set the output content of the measurement result.
This item is displayed only the Amplifier Unit whose [TRIG/TRIG] setting is set to [I/O].

▶ MENU Mode-[SYS2]-[LINKSET]-[OUTPUT]

| Setting | Description |
|---|---|
| ALL | The measurement results of all gang-mounted Amplifier Units are integrated, and output as an overall judgment result. |
| EACH (defalut value) | The measurement result of each Amplifier Unit is output from the respective Amplifier Unit. |

# Customizing Measurement conditions

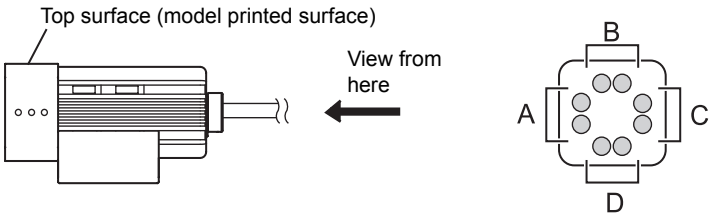
EXP MENU

The display items from [CUSTM] onwards differ according to the teaching type set at [ITEM].

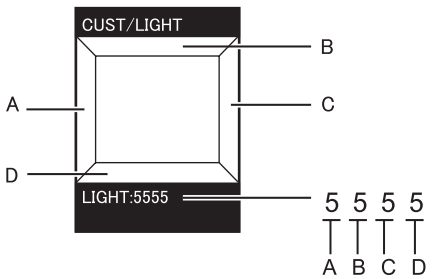
## Common items

### ■ Adjusting light emission

Adjust the intensity of the light emitted from Sensor Head.
The light intensity of each adjusted section is displayed as a 4-digit number.




An image of how light is emitted is displayed on screen.




The light intensity can also be adjusted partially (A to D).

Adjust the light intensity by the UP/DOWN keys.

| Setting | Description |
|---|---|
| 0 to 5 (default value: 5) | 0: Out, 1 to 5: Light intensity increases the larger the number. |

▶ MENU Mode-[CUSTM]-[LIGHT]

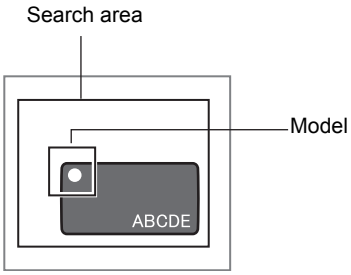
**1. Switch the light intensity by the UP/DOWN keys.**
When performing partial adjustment
- LEFT/RIGHT keys: Select the adjustment section.
- UP/DOWN keys: Select the light intensity.

**2. Press the SET Key to apply the setting.**

# PATTERN/SEARCH, MATCH

## ■ Changing the search area

Change the area to search the model in.
Searches can be performed in the entire detection range. However, restricting the search area can reduce the processing time and increase detection accuracy.
Specify the top left and bottom right of the search area.




▶ MENU Mode-[CUSTM]-[SEARCH AREA]

## ■ Setting the rotation range of a workpiece

This item is displayed only when [SEARCH] is set.
Set this item when even a tilted workpiece is to be set as a non-defective item.

▶ MENU Mode-[CUSTM]-[ROTATION]

| Setting | Description |
|---|---|
| ±10° (default value) | Set the range of acceptable tilt |
| ±20° | |
| ±30° | |
| ±45° | |

CHECK! The larger the range of acceptable tilt, the longer it takes to performe measurement.

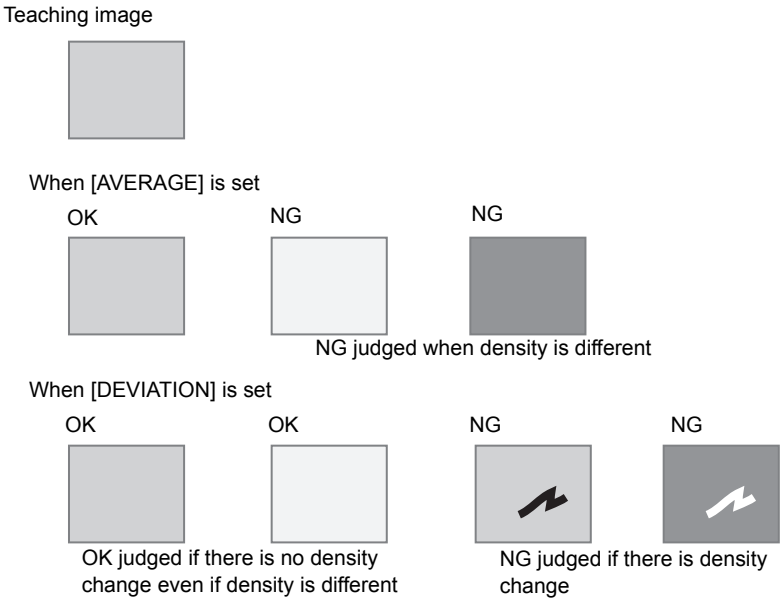
# BRIGHT

## ■ Changing the detection content

Select the content whose brightness is to be detected.

▶ MENU Mode-[CUSTM]-[METHOD]

| Setting | Description |
|---|---|
| AVERAGE (default value) | Performs detection using brightness (average density value).<br>Whether or not an object is lighter or darker is detected by referring to the density during teaching. |
| DEVIATION | Performs detection using sudden changes (density deviation) in density.<br>Select this to detect the presence of scratches or dirt. |



# AREA

## ■ Reversing black-and-white images

Reverse the currently displayed binary image.
As white pixels are targeted for measurement, select which part of the measured area is to be set to white pixels.

▶MENU Mode-[CUSTM]-[COLOR]

| Setting | Description |
|---|---|
| WHITE (default value) | Select which part of the measurement area is to be set as white pixels. |
| BLACK | |

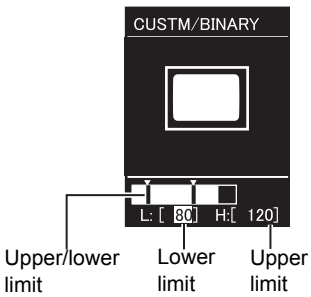


## ■ Changing the binarization level

Set the level for converting 256-tone contrast image captured from Sensor Head to a binary image.

▶MENU Mode-[CUSTM]-[BINARY]

| Setting | Description |
|---|---|
| 0 to 255 | As white pixels are targeted for measurement, adjust the binarization level so that the measurement area is converted to white pixels. |

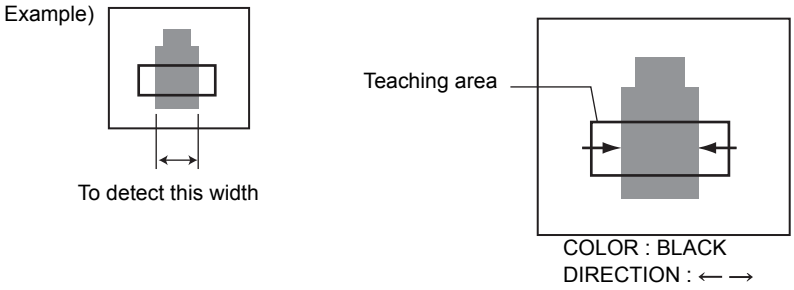



LEFT/RIGHT keys: Select upper limit/lower limit.
UP/DOWN keys: Change values.

# WIDTH

## ■ Specifying edge detection conditions

Set the direction in which edges are searched and the change in density.




### ● Selecting the color of edges

Select the direction of density change for the edge to be detected.

▶ MENU Mode-[CUSTM]-[COLOR]

| Setting | Description |
|---|---|
| WHITE (default value) | A change from dark to light is judged as an edge. |
| BLACK | A change from light to dark is judged as an edge. |

### ● Selecting the edge detection direction

Select the direction in which edges are searched.

▶ MENU Mode-[CUSTM]-[DIRECTION]

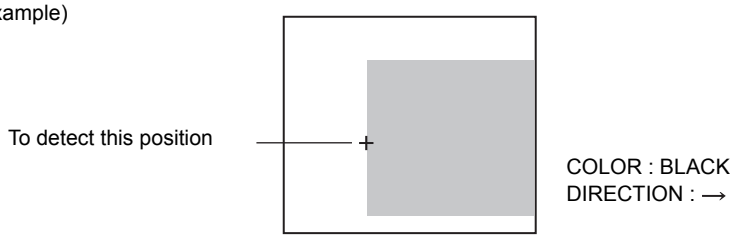
| Setting | Description |
|---|---|
| ↑ ↓ | Searches in the vertical direction. |
| ← →(default value) | Searches in the horizontal direction. |

# POSITION

## ■ Specifying edge detection conditions

Set the direction in which edges are searched and the change in density.

Example)




### ● Selecting the color of edges

Select the direction of density change for the edge to be detected.

▶ MENU Mode-[CUSTM]-[COLOR]

| Setting | Description |
|---|---|
| WHITE (default value) | A change from dark to light is judged as an edge. |
| BLACK | A change from light to dark is judged as an edge |

### ● Selecting the edge detection direction

Select the direction in which edges are searched.

▶ MENU Mode-[CUSTM]-[DIRECTION]

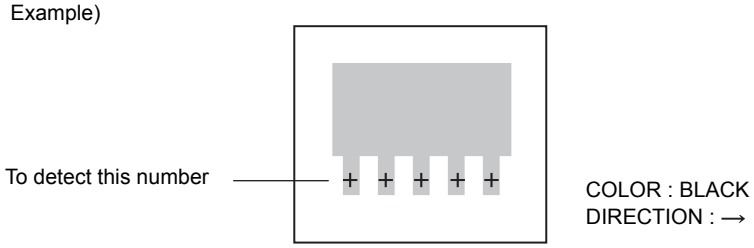
| Setting | Description |
|---|---|
| ↓ | Searches from top to bottom. |
| →(default value) | Searches from left to right. |

# COUNT

## ■ Specifying edge detection conditions

Set the direction in which edges are searched and the change in density.

Example)




### ● Selecting the color of edges

Select the direction of density change for the edge to be detecte.

▶ MENU Mode-[CUSTM]-[COLOR]

| Setting | Description |
|---|---|
| WHITE (default value) | A change from dark to light is judged as an edge. |
| BLACK | A change from light to dark is judged as an edge |

### ● Selecting the edge detection

Select the direction in which edges are searched.

▶ MENU Mode-[CUSTM]-[DIRECTION]

| Setting | Description |
|---|---|
| ↓ | Searches from top to bottom. |
| → (default value) | Searches from left to right. |

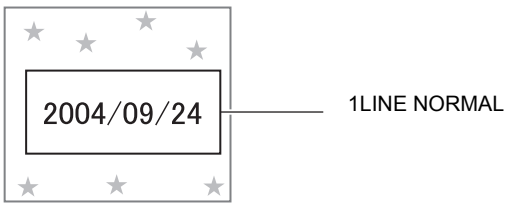
# CHARA/CHARA 1, CHARA 2

## ■ Set the model registration conditions for characters

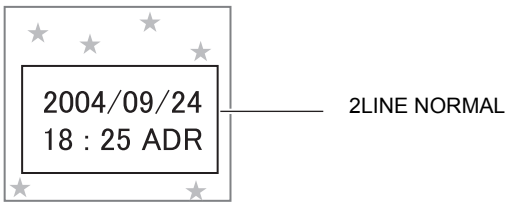
This item is displayed only when [CHARA 2] is set.
Select the number of characters in the preset teaching area.
Select the number of characters being within a certain number of characters on one or two lines.

Selection guidelines

• 8 characters, 1 line




• 8 characters, 2 line




▶ MENU Mode-[CUSTM]-[MDL DIV]

| Setting | Description |
|---|---|
| 1LINE SHORT | Select this when the character string is 6 characters or less on 1 line. |
| 1LINE NORMAL (default value) | Select this when the character string is 8 characters or less on 1 line. |
| 1LINE LONG | Select this when the character string is 15 characters or less on 1 line |
| 2LINE SHORT | Select this when the character string is 6 characters or less on 2 lines. |
| 2LINE NORMAL | Select this when the character string is 8 characters or less on 2 lines. |

CHECK!

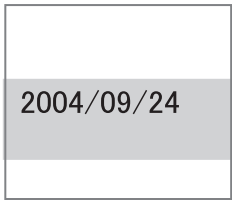
The number of characters in the above table are for reference only. When there are more characters than the number of reference characters in the selected item, measurement accuracy drops.

## ■ Select whether or not to perform Position compensation

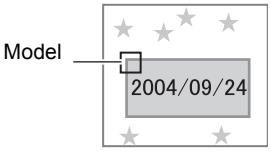
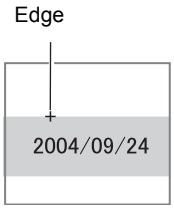
Set Position compensation for improving detection accuracy in the following instances:

When there is a pattern in the detection range

When printed text is out of position




▶MENU Mode-[CUSTM]-[MODE]

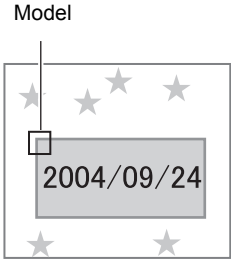
| Setting | Description |
|---|---|
| NONE | The position is not corrected. |
| MODEL | The model is used to correct the position.<br>Select this when there is a characteristics part such as a corner of a text box.<br>  |
| EDGE | The edge position is used to correct the position.<br>  |

## ■ Select the content of position compensation

### ● Registering models

Set this when [MODEL] is selected to [MODE]

Specify the top left coordinate and bottom left coordinate of the model.

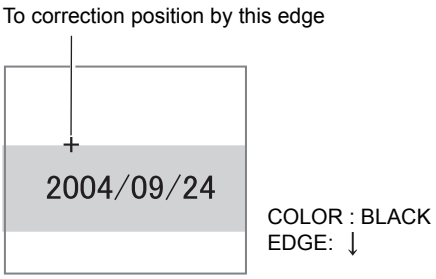



▶MENU Mode-[CUSTM]-[MODE DTL]-[MODEL]

## ● Specifying edge detection conditions

Set this when [EDGE] is selected to [MODE].
Set the direction in which edges are searched and the change in density.

Example)




• Selecting the color of edges
Select the direction of density change for the edge to be detected.

▶MENU Mode-[CUSTM]-[MODE DTL]-[COLOR]

| Setting | Description |
|---|---|
| WHITE | A change from dark to light is judged as an edge. |
| BLACK (default value) | A change from light to dark is judged as an edge. |

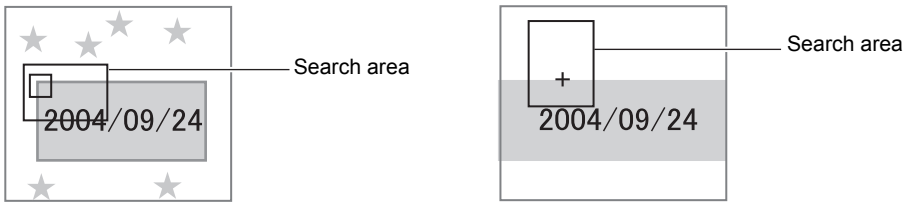
• Selecting the edge detection direction
Select the direction in which edges are searched.

▶MENU Mode-[CUSTM]-[MODE DTL]-[DIRECTION]

| Setting | Description |
|---|---|
| ↑ (default value) | Searches from bottom to top. |
| ↓ | Searches from top to bottom. |
| → | Searches from left to right. |
| ← | Searches from right to left. |

## ■ Changing the search area

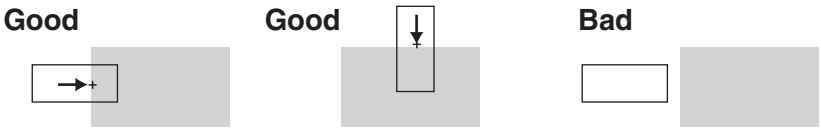
Change the area to search edges or the model in.
Specify the top left coordinate and bottom left coordinate of the area.




▶MENU Mode-[CUSTM]-[MODE DTL]-[SEARCH AREA]

CHECK!

When searching edges
Measurement can be performed only when the search area contains an edge.
Determine the size and position of the area taking the movement range of the workpiece into consideration.



MEMO

# Section 4
# APPENDIX


| | |
|---|---|
| Troubleshooting | 78 |
| Error Messages and Remedies | 79 |
| Q&A | 80 |
| Run Mode Display Item List | 81 |
| Specifications and External Dimensions | 83 |
| INDEX | 89 |

# Troubleshooting

This section describes countermeasures for temporary hardware problems. Check the malfunction in this section before sending the hardware for repair.

| Problem | Probable cause and possible countermeasure | Pages |
|---|---|---|
| OUTPUT indicator does not lit. | • Check the setting of [SYS2]-[OUTPUT]-[ON STATUS].<br>To lit the indicator (OUTPUT signal ON) when the judgment is OK, select [OK ON], and to lit the indicator (OUTPUT signal ON) when the judgment is NG, select [NG ON]. | p.61 |
| RUN indicator does not lit. | • Is the operating mode switch set to “RUN”? | p.44 |
| Dark LCD screen | • Is the “Eco” mode function set?<br>The “Eco” mode is set if pressing any key automatically returns to the original brightness.<br>The brightness is maintained when the “Eco” mode setting is canceled. Note, however, that the life of the LCD backlight is shortened. So, we recommend setting the “Eco” mode. | p.60 |
| Images are not displayed. | • Is the Sensor Head connector connected correctly?<br>• Is the brightness of the LED light set to a dark value? | p.40<br>p.65 |
| Measurement results are not displayed. | • Is the operating mode switch set to “RUN”? | p.44 |
| The TRIG signal (input signal) is not accepted. | • Are all cables connected correctly?<br>• Is the signal line disconnected?<br>• Is the operating mode switch set to “RUN”? | p.31<br><br>p.44 |
| The OUTPUT signal is not output. | • Is the TRIG signal being input?<br>• Are all cables connected correctly?<br>• Is the signal line disconnected?<br>• Is the operating mode switch set to “RUN”? | p.31<br><br><br>p.44 |
| The ENABLE signal does not turn ON. | • Is the operating mode switch set to “RUN”? | p.44 |
| The bank is not switched even if the bank switching signal is input from the outside. | • Is the bank switching method set to [I/O]?<br>When the bank switching method is set to [KEY], only switching by key entry is enabled. For this reason, the external input of the BANK 1 to 3 are not accepted.<br>• Is the operating mode switch set to “RUN”? | p.58<br><br><br>p.44 |

# Error Messages and Remedies

| Error messages | Cause | Countermeasure | Pages |
|---|---|---|---|
| HEAD IS NOT CONNECTED | The Sensor Head is not connected correctly. | Make sure that the Sensor Head is connected correctly. | p.38 |
| NEIGHBOR UNIT IS NOT CONNECTED | The Amplifier Units are not coupled correctly. | Make sure that the Amplifier Units are connected correctly. | p.27 |
| SYSTEM ERROR ERROR CODE ?? | Failed to configure FPGA.<br>Failed to initialize LCD.<br>Failed to recognize Amplifier Unit.<br>Failed to load data from flash memory.<br>Faulty hardware operation<br>Faulty software operation | Faulty Amplifier Unit<br>Contact your OMRON representative. | - |
| TEACHING FAILED | The workpiece is not projected correctly.<br>The teaching area is not set at the appropriate position. | Set the area so that the workpiece is projected in the field-of-view.<br>Make sure that the appropriate teaching area is set. | p.38<br>p.49 |

In the following instances, error messages are not displayed, but the ERROR signal turns ON.

| Cause | Countermeasure | Pages |
|---|---|---|
| TRIG was input while ENABLE was OFF. | Wait until ENABLE is turned ON and then input TRIG. | p.34 |
| Failed to teach from external device. | Set the area so that the workpiece is projected in the field-of-view.<br>Make sure that the appropriate teaching area is set.<br>Make sure that TRIG timing is appropriate in the workpiece move teaching mode. | p.38<br>p.49<br>p.34 |

# Q&A

| Question | Answer |
|---|---|
| Can I turn LED light emission of the Sensor Head OFF? | Yes, you can.<br>[CUSTM]-[Set LIGHT] to [0000].<br>p.65 |
| What should I do to set the measurement time as short as possible? | There are two ways of setting a shorter measurement time:<br>• [Set CUSTM]-[IMAGE RATE] to [HIGH SPEED]. Note, however, that image processing becomes rougher, and measurement accuracy drops.<br>p.59<br>• Switch the screen display during measurement to “Display only image”.<br>The measurement time can be reduced proportionate to the reduction in display time.<br>p.57 |
| Teaching is not going well. What should I do? | • Workpiece move teaching mode<br>A probable cause is that the workpiece is not properly in the teaching area as intended.<br>Change to the workpiece stop teaching mode or teaching by key operation.<br>• A probable cause is that teaching is not successful because an image is too dark or too bright.<br>Adjust light emission at [CUSTM]-[LIGHT] so that the workpiece is projected clearly, and execute teaching again.<br>p.65 |

# Run Mode Display Item List

The following tables show the characters that are displayed on the LCD monitor and their meanings

Characters in parentheses ( ) are the characters that are displayed in the enlarged display mode.

## ■ Items displayed in common at [ITEM]

| Display Characters | Meaning |
|---|---|
| AVE | Average value of measurement result |
| DRANGE | Min. and max. of measurement result<br>XX – YY (min. value – max. value) |
| JG | Judgment result (OK/NG) |
| MCONT | Measurement count (1 to 9999999) |
| NG% | NG occurrence ratio (NG count/measurement count) |
| TH | Judgment threshold value<br>In the case of the upper/lower limits, XX – YY (lower limit – upper limit) is displayed. |
| TIME | Measurement time<br>The shortest measurement time when the display image is set to “Display only image”. |

## ■ Items displayed individually

### ● SEARCH, MATCH, CHARA 2

| Display Characters | Meaning |
|---|---|
| SCORE(SCR) | Correlation values of calculated model |

### ● BRIGHT

| Display Characters | Meaning |
|---|---|
| DENAVE(DAV) | Density average value |
| DENDEV(DEV) | Density distribution value |

### ● AREA

| Display Characters | Meaning |
|---|---|
| MES | Area value (value obtained by normalizing with area value during teaching taken as 100) |

### ● POSITION

| Display Characters | Meaning |
|---|---|
| GAP | Deviation from reference position |

### ● WIDTH

| Display Characters | Meaning |
|---|---|
| WID | Edge width |

## ● COUNT

| Display Characters | Meaning |
|---|---|
| COUNT(CNT) | Count |

## ● CHARA 1

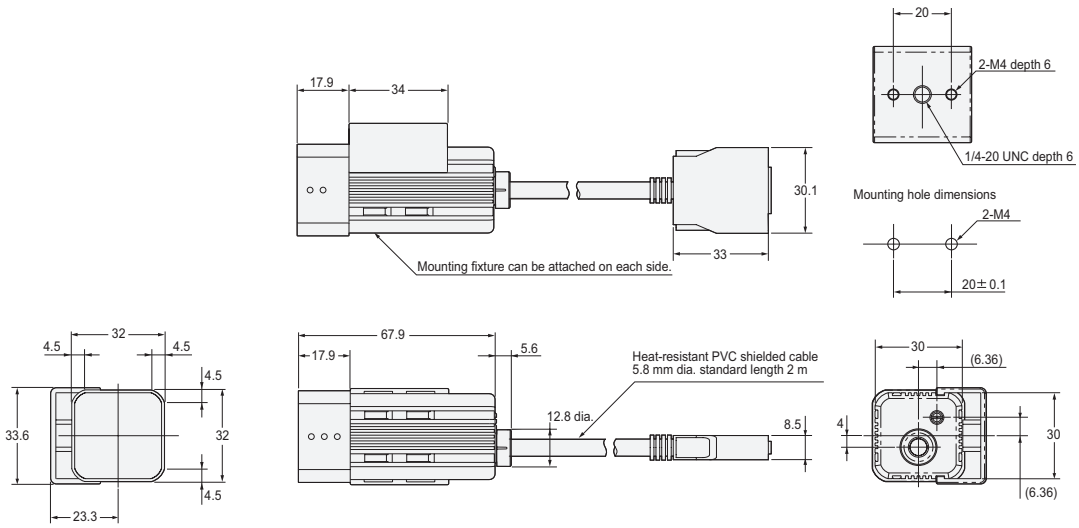
| Display Characters | Meaning |
|---|---|
| MES | Area value (value obtained by normalizing with area value during teaching taken as 100) |
| DENAVE(DAV) | Density average value |
| DENDEV(DEV) | Density distribution value |

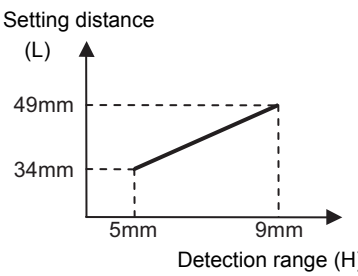
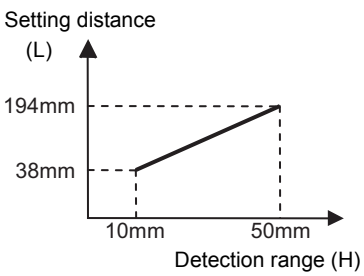
# Specifications and External Dimensions

## Sensor Head

ZFV-SR10/SR50

(Unit: mm)

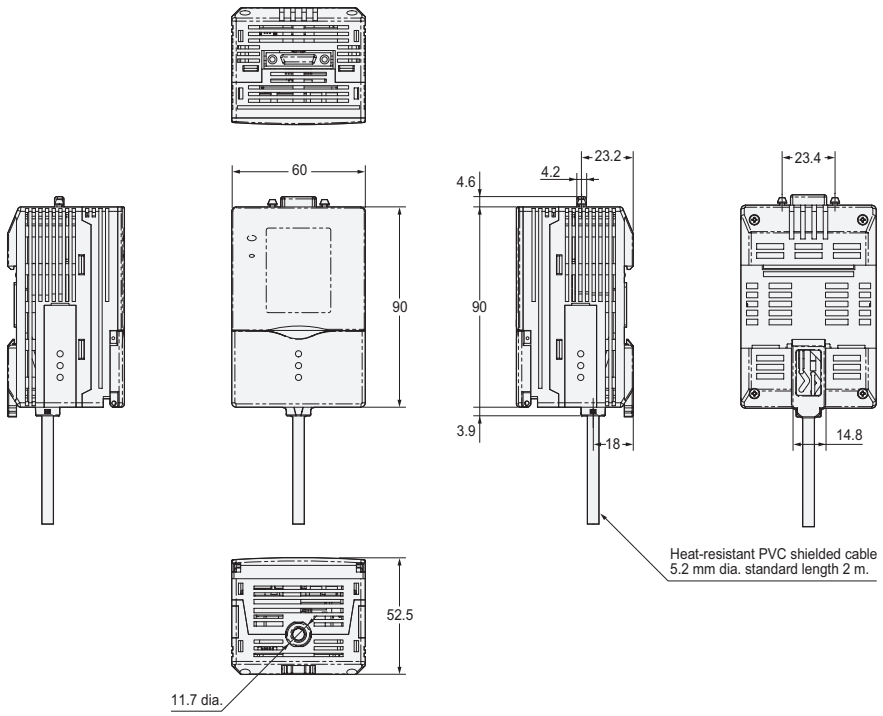


| Item | ZFV-SR10 (Narrow View) | ZFV-SR50 (Wide View) |
|---|---|---|
| Setting distance (L) | 34 to 49 mm | 38 to 194 mm |
| Detection range (H×V) | 5 × 4.6 mm to 9 × 8.3 mm | 10 × 9.2 mm to 50 × 46 mm |
| Relation between setting distance and detection range |  |  |
| Guide light | Provided (center, sensing area) | |
| Built-in lens | Focus: f15.65 | Focus: f13.47 |
| Object lighting method | Pulse lighting | |
| Object light source | Eight red LEDs | |
| Sensing element | 1/3-inch CCD, partial scan | |
| Shutter | Electronic shutter, shutter time: 1/1,000 to 1/4,000 | |
| Power supply voltage | 15 VDC (Supplied from Amplifier Unit.) | |
| Current consumption | Approx. 200 mA | |
| Dielectric strength | 1,000 VAC, 50/60 Hz for 1 min | |
| Vibration resistance (destruction) | 10 to 150 Hz, 0.35-mm single amplitude, 10 times each in X, Y, and Z directions for 8 min | |
| Shock resistance (destruction) | 150 m/s$^2$, three times each in six directions (up/down, left/right, forward/backward) | |
| Ambient temperature | Operating: 0 to 40 °C, Storage: -25 to 65°C (with no icing or condensation) | |
| Ambient humidity | Operating and storage: 35% to 85% (with no condensation) | |
| Ambient atmosphere | Must be free of corrosive gas. | |
| Connection method | Prewired, Standard cable length: 2 m | |
| Degree of protection | IEC60529, IP65 | |
| Materials | Case: ABS, Mounting bracket: PBT | |
| Weight | Approx. 200 g (including mounting bracket and cord) | |
| Accessories | Mounting bracket (1), Ferrite core (1), Instruction sheet | |

# Amplifier Unit

ZFV-A□□

(Unit: mm)



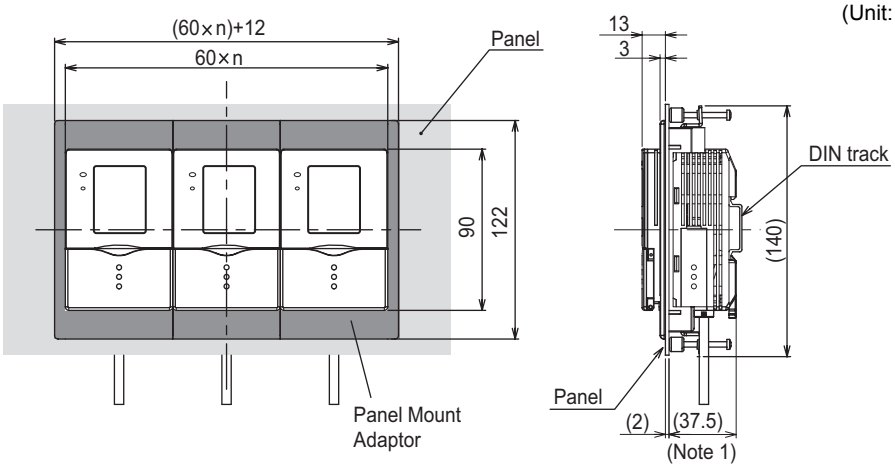
| Item | Single-function Models | | Standard Models | |
|---|---|---|---|---|
| | ZFV-A10 | ZFV-A15 | ZFV-A20 | ZFV-A25 |
| Output method | NPN | PNP | NPN | PNP |
| Inspection items | Pattern (PTRN), Brightness (BRGT) | | Patterns (PTRN), Brightness (BRGT), Area (AREA), Width (WID), Position (POSI), Count (CNT), Characters (CHAR) | |
| Teaching area | Rectangular, one area | | | |
| Teaching area size | • Pattern (PTRN), Brightness (BRGT): Any rectangular area (256 × 256 max.)<br>• Area (AREA), Width (WID), Position (POSI), Count (CNT), Characters (CHAR): Any rectangular area (full screen max.) | | | |
| Sensing area | Full screen | | | |
| Resolution | 468 × 432 (H × V) max. | | | |
| Bank selection | Supported for 8 banks. | | | |
| Response time | Pattern (PTRN), Brightness (BRGT): High-speed: 4 ms, Standard: 8 ms,<br>High-precision: 12 ms (not using partial scan)<br>Area (AREA), Width (WID), Position (POSI), Count (CNT),<br>Characters (CHAR): 128 × 128: 15 ms max. | | | |
| Other functions | Control output switching: ON for OK or ON for NG<br>ON delay/OFF delay, One-shot output, “ECO” mode | | | |
| Output signals | (1) Control output (OUTPUT), (2) Enable output (ENABLE),<br>(3) Error output (ERROR) | | | |
| Input signals | (1) Simultaneous measurement input (TRIG) or Continuous measurement input (TRIG), Switched by using menu.<br>(2) Bank selection inputs (BANK1 to BANK3)<br>(3) Workpiece still teaching (TEACH) or Workpiece moving teaching (TEACH), Switched by using menu. | | | |
| Sensor Head interface | Digital interface | | | |
| Image display | Compact TFT 1.8-inch LCD (Display dots: 557 × 234) | | | |
| Indicators | • Judgement result indicator (OUTPUT) • Inspection mode indicator (RUN) | | | |
| Operation interface | • Cursor keys (up, down, left, right) • Setting key (SET) • Escape key (ESC)<br>• Operating mode switching (slide switch) • Menu switching (slide switch)<br>• Teaching/Display switching key (TEACH/VIEW) | | | |
| Power supply voltage | 20.4 to 26.4 VDC (including ripple) | | | |
| Current consumption | 600 mA max. (with Sensor Head connected) | | | |
| Dielectric strength | 1,000 VAC, 50/60 Hz for 1 min between leads and Amplifier Unit case | | | |
| Noise immunity | 1 kV, Pulse rise: 5 ns, Pulse width: 50 ns, Burst duration: 15 ms, Cycle: 300 ms | | | |
| Vibration resistance | Destruction: 10 to 150 Hz, 0.1-mm single amplitude, 10 times each in X, Y, and Z directions for 8 min | | | |
| Shock resistance | Destruction: 150 m/s$^2$, three times each in six directions (up/down, left/right, forward/backward) | | | |
| Ambient temperature | Operating: 0 to 50°C<br>Storage: -25 to 65°C (with no icing or condensation) | | | |
| Ambient humidity | Operating and storage: 35% to 85% | | | |
| Ambient atmosphere | Must be free of corrosive gas. | | | |
| Degree of protection | IEC60529, IP20 | | | |
| Materials | Polycarbonate | | | |
| Weight | Approx. 300 g (including cord) | | | |
| Accessories | Ferrite core (1), Instruction sheet | | | |

# Panel Mount Adapters

ZS-XPM1/XPM2

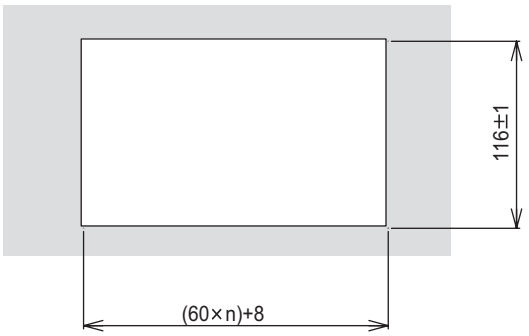
When mounting on a panel

(Unit: mm)




Note 1 : Dimensions are shown for a panel thickness of 2.0 mm.

Panel cutout dimensions



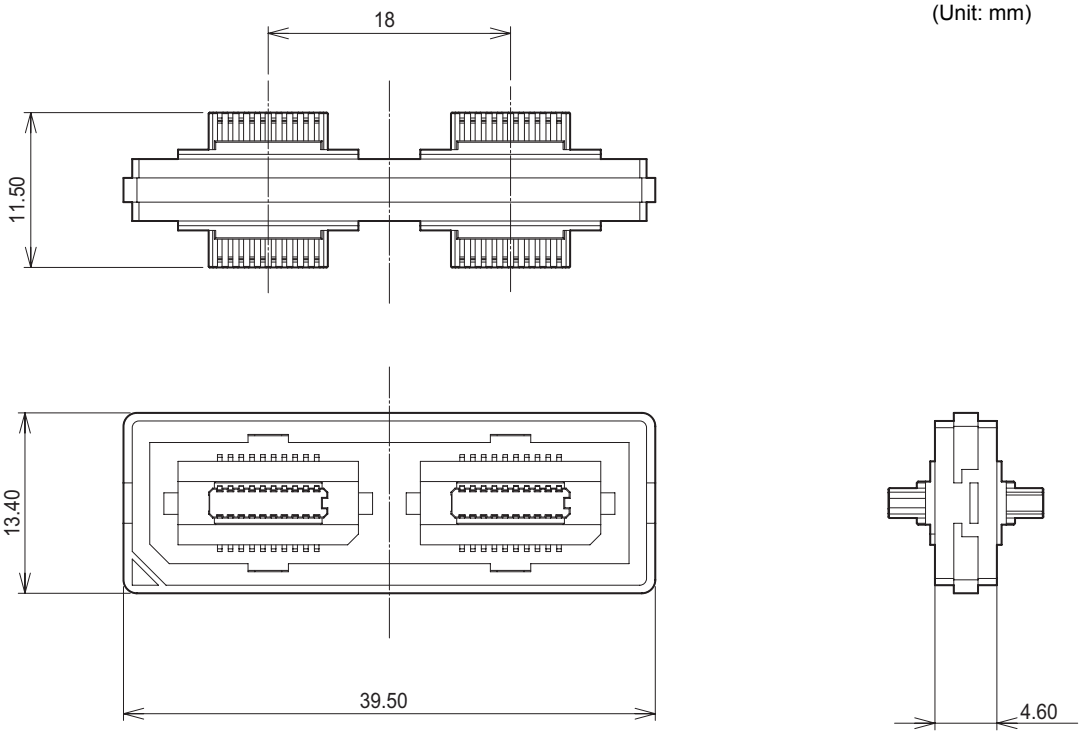

n : Number of gang-mounted controllers (1 to 10)

| Item | ZS-XPM1 (for 1st unit) | ZS-XPM2 (for 2nd unit onwards) |
|---|---|---|
| Appearance | | |
| Vibration resistance (destructive) | 10 to 150 Hz, 0.7-mm double amplitude, 80 min each in X, Y, and Z directions | |
| Shock resistance (destructive) | 300 m/s$^2$ 3 times each in six directions (up/down, left/right, forward/backward) | |
| Materials | Polycarbonate (PC), etc. | |
| Weight | Approx. 50g | |

# Control Link Unit

ZS-XCN

(Unit: mm)




| Item | ZS-XCN |
|---|---|
| Ambient temperature | Operating: 0 to 50°C, Storage: -15 to +60°C (with no icing or condensation) |
| Ambient humidity | Operating and storage: 35% to 85% (with no condensation) |
| Vibration resistance (destructive) | 10 to 150 Hz, 0.7-mm double amplitude, 80 min each in X, Y, and Z directions |
| Shock resistance (destructive) | 300 $m/s^2$ 3 times each in six directions (up/down, left/right, forward/backward) |
| Materials | Polycarbonate (PC), etc. |
| Weight | Approx. 10g |

# INDEX


## A

ADJ mode 44
Adjusting light emission 65
ALL CLEAR 60
Amplifier Unit 23
  Attaching the ferrite core 23
  Installing the Amplifier Unit 23
  Specifications and External Dimensions 85
Application Expanded Configuration 16
Application extended connection 63
Area value 54
AVERAGE 67
Average density value 53

## B

BANK 58
Bank 58
  Clearing banks 58
  Copying banks 58
  Setting the bank switching method 58
  Switching banks 58
Basic Configuration 16
Binarization 68
BINARY 68

## C

CLEAR 58
COLOR 68, 70, 71, 74
COPY 58
Correlation value 53, 56
Coupler 19

## D

Density deviation value 53
Density distribution value 56
Detection content 49
  Brightness/scratches, dirt 49
  Characters 49
  Number 49
  Pattern/shape/presence 49
  Position 49
  Size/area 49
  Width 49
Detection range 38, 84
DEVIATION 67
DIRECTION 69, 70, 71, 74

## E

“ECO” MODE 60
“Eco” mode 60
Edge 69
  Color of edges 69, 70, 71
  Edge detection direction 69, 70, 71
Edge level 54, 55
Edge width 54
Expert menu 44

## F

Focus adjustment control 20

## G

Gang mounting 27

## I

I/O cable 31
I/O Circuit Diagrams 32
IMAGE RATE 59
Initializing setup data 60
Input/output 61
  ON conditions 61
  One-shot output 61
Installation 22
  DIN track 23
  Gang mounting 27
  Panel 25
Installation distance 38

## K

Key Operations 45

**L**

LIGHT 65

**M**

MDL DIV 72
MEAS TYPE 59
Measurement 57
  Adjusting the measurement speed 59
  Measurement time 57
  Measurement timing 59
  Switching the display during measurement 57
MENU mode 44
  Description of MENU mode 44
  List of Setting Items 46
Menu selector switch 18
METHOD 67
MODE 73
Mode 44
Mode selector switch 18
MODEL 73

**N**

Narrow View 84
Number 55

**O**

OFF DELAY 63
OFF delay time 63
ON DELAY 62
ON delay time 62
ON STATUS 61
ONE SHOT 62
One-shot output 61
  Continuous measurement 61
  Output time 62
  Synchronous measurement 61
Operating modes 44
OUTPUT 64
OUTPUT TIME 62

**P**

Part Names and Functions 18
  Amplifier Unit 18
  Sensor Head 20
Position 55
Power supply 16

**R**

ROTATION 66
Rotation range 66
RUN mode 44

**S**

SEARCH AREA 66, 75
Search area 66
Sensor Head 37
  Attaching the ferrite core 37
  Connecting the Sensor Head 40
  Installation distance 38
  Installing the mounting fixture 37
  Specifications and External Dimensions 83
Single-function Models 86
Standard menu 44
Standard Models 86
SWITCH 58
Switching menus 44
Switching the display 57

**T**

TEACH TYPE 59
Teaching 35
  AREA 50
  BRIGHT 50
  CHARA 52
  COUNT 51
  PATTERN 49
  POSITION 51
  Teaching Flow 48
  Types of Teaching 49
  WIDTH 51
  Workpiece move teaching 36
  Workpiece stop teaching 35
Threshold Values 53
  AREA 54
  BRIGHT 53

CHARA 1 56
CHARA 2 56
COUNT 55
MATCH 53
POSITION 55
SEARCH 53
WIDTH 54
Timing charts 34
Continuous measurement 34
Synchronous measurement 34
TRIG 64

## V

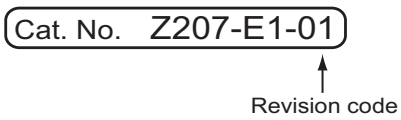
VERSION 60
Version 60

## W

Wide View 84

# Revision History

A manual revision code appears as a suffix to the catalog number at the bottom of the front and back covers of this manual.




| Revision code | Date | Revised contents |
|---|---|---|
| 01 | August 2004 | Original production |